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## THE LIMELIGHT OF THE MOON—AN ALTERNATIVE THEORY.

By DONALD P. BEARD.

There is perhaps no phenomenon connected with the moon's surface more instantly striking, nor yet, strangely enough, more completely neglected than the bright rays radiating from Copernicus, Tycho, Kepler, Apollonius, Proclus and other craters.

The writer, who has devoted nearly fifteen years of study to astronomy in general and to the lunar planet in particular, has ever sought an answer to the "ray riddle" propounded by this strange phenomenon of the moon. Even as a boy of thirteen years, he sold the "Saturday Evening Post" and other papers to earn money with which to purchase a two-inch spyglass. This gave him the wings of Pegasus, to wander out into the starlit fields of space and soar over the moon, like the acrobatic cow in old Mother Goose's nursery rhyme.

Within recent months the writer has been aided in his researches on the lunar surface details by the kindness of an interested friend, Mrs. Isaac M. Ridge of Kansas City, Missouri. This aid took the form of a fine four-inch telescope, its objective combination ground and figured by the late Prof. Ganz of Missouri University nearly a half century ago. This instrument was placed in my hands nearly two years since by Mrs. Ridge, who remarked that "it was gathering dust in the garret, and was not being usefully employed where it was." Some four decades ago her husband, the late Dr. Isaac M. Ridge, was a practicing physician of Kansas City who had a penchant for astronomy—and more important, the means to gratify it. About fifteen years ago Dr. Ridge passed away, but his widow, wishing to place in the hands of an earnest student the key that had unlocked the gates to the glories of the firmament for the venerable Doctor, placed it in my stewardship, to employ as I saw fit in solving the mysteries of blazing suns and the cold moon and the created worlds of infinite space.

Accordingly, in pursuance of a resolution to justify my generous friend's desire that I should devote the powers of the glass to serious observational work, I have been scanning the lunar surface closely the past few months. The intent of this scrutiny has resolved itself into a research on the visibility of the anomalous bright "rays" that appear shortly after sunrise upon them, and augment their refulgence toward full moon.

OBSERVATIONS.

The writer ventures to submit to the readers of POPULAR ASTRONOMY the following observations made with the four-inch Ridge telescope on sundry occasions, all tending to controvert the hackneyed statement that the rays are only observable at full phase.

Entry in my observation book, date of March 30, 1923, 12:45 A. M., reads: "Observed three major rays on terminator side of Kepler extend nearly their normal length, with co-longitude of sunrise terminator at only 53 degrees (afterwards designated as the C. S. T.). Reiner (crater) just standing on sunrise terminator. Also, traced major ray past east[1] wall of Scheiner to within four degrees of terminator. Ray system of Copernicus faintly traceable."

Clouds intervened and prevented further observation until the night of April 22. At 9:45 P. M. on that night I find this entry: "Ray through crater Bessel traceable for seven or eight degrees. Linnè bright; about 5° in from sunrise line. Apollonius minor ray system faintly discernible. (Latter a small crater at the eastern edge of Mare Crisium.) Moon 6 days old. Clouds came up at 9:58."

FIG. 1. "Tycho Ray," from Altai Mts. (h) to Fracastorius (62) Polybius = 92. April 22, 1923, 9:45 G. M. T. Power 180. C. S. T. =2°.

FIG. 2. "Copernicus Ray" through ruined crater Stadius (381). April 24, 1923. Time 11:50 G. M. T. Power 180. C. S. T. = 21°—.

On that night the writer made a sketch of a ray from Tycho that leads across the Altai Range and the Mare Nectaris, with crater Polybius in its path (See Fig. 1). While the moon was scarcely more than a crescent, this ray was faintly observed between the Altai Range and Polybius, but less distinctly from the latter to Fracastorius, on the border of the Nectar Sea.

Another cloudy night supervened, but on April 24, 11:50 P. M.,

[1] Right hand side, as seen on inverted lunar disk—not left hand. This condition is equivalent to the transposition of the right and left hands as seen in a mirror.

a sketch was secured of one of the rays of Copernicus, shown in Fig. 2. Copernicus itself stood on the sunrise terminator, its majestic inner terraces and floor lost in a blot of Stygian shadow, while the rising sun only illumined the summit of its wreathed rim. Reference to an actual photograph (Fig 3, Plate XII) taken at Yerkes Observatory of Copernicus at nearly the identical phase—only a few hours later than the C. S. T. of my observation—will bear out my contention that the ray system from this crater is fairly noticeable and complete, even though the risen sun has not advanced more than five hours beyond the centre of the great crater itself.

Moreover, the crater Pythias, north of Copernicus (one inch below in photo) betrays an extraordinary brightness of its walls, suggestive of the presence of snow or hoar frost about its mouth and outer slopes. Also, certain of the dolmen-like hills between Copernicus and Pythias —lunar replica of the Stonehenge pillars of Britain—their axes pointed north-and-south, bear remarkably white summits favouring the idea of a similar condition.

The accompanying sketch of the ray lying through the ruined crater Stadius was made at 11:50 P. M. on April 24, and reveals also some of the *dark* rays that apparently spread radially out from Copernicus, (to be seen also on the photo, Fig. 3) and resembling vast sheets of humus soil on our planet. And such, indeed, these dark splashes on the grey lunar plains may in truth prove to be, under a recent theory of the lunar surface formations to be discussed later. They are almost a complement of the associated bright rays, and evince physical kinship with them.

The present writer is not aware that this feature has been mentioned by any other selenographer save one, Doctor E. G. Davis of Kansas City, Kansas, whose theory in outline will be presented later. However, this detail must have been noticed by others who hold the moon under their scrutiny, but they evidently evaded a discussion of its nature. Can these "dark rays" that lie across the moon's *maria*, intertwined with their more luminous kin, serve as a clue to the explanation of the moon's physical history?

A further circumstance connected with these lunar rays should be noted. When a photo of the great southwest region comprised between Tycho on the south and Alphonsus and Ptolemaeus on the north (Fig. 4) was scrutinised under a powerful microscope (magnification = 210 diameters) an interesting condition was revealed. Fully a third of the minute "pin-prick" craters scattered over the floor of the Mare Nubium are either situated in light-coloured snow-like material, or are centres of minor ray systems of their own. The rays from these craterlets are extremely straight and narrow, somewhat like those from Apollonius and Kepler. The crater Messier "a," one of two twin craterlets in the Mare Fœcunditatis, sends out two or three filaments of luminous matter like Apollonius, and others could be mentioned.

Even a superficial study of these bright ray systems discloses the fact that two types or species persist: the long, straight meridian-like rays from Tycho and the totally dissimilar "feathery" rays that extend plume-like from Copernicus out over the surrounding plain of the Mare Imbrium.

The rays from Tycho exhibit an absolute indifference toward minor changes of level or obstructing craters in their paths, continuing a predetermined course across the moon with amazing contempt for either. One ray, that leaves its focus at Tycho, leads across the crater Saussure, just adjoining the former. This band, which intersects Saussure, "may be seen crossing its floor, and less distinctly, yet clearly enough, it appears on the steep inside walls of the cavity....."[2]

The foregoing is quoted from Prof. N. S. Shaler's monograph, "A General Description of the Moon." This Harvard geologist, who passed away several years ago, made a special study of the lunar surface structure. His remarks, made in 1903, are pertinent here. Touching on the physical nature of the rays, he states:[3] "It should be noted that the light bands in most instances diverge from more or less broad fields of light colour about the crater-like pits; fields which have the same habit of glowing under a high illumination: in fact, a large part of the surface of the moon....becomes thus relatively brilliant at full, although it lacks that quality at the earlier and later stages of the lunar day."

In his paper entitled "Surface Features of the Moon, the Earth and Mars",[4] Col. Millis has given considerable space to the impact theory, and states that it is competent to explain that body's peculiar formations. While it is true that the impact of a meteor composed chiefly of sulphur or zinc or tin might produce a splash with radiating white streaks similar to the rays from Kepler (See Figures 3 and 5), or yield an effect duplicated by the dropping of bombs on Bolling Field, D. C., from army airplanes, it yet fails to account for the feathery, meandering streaks from Copernicus, as well as the peculiar associated dark rays mentioned above.

The deposition of dark humus soil on the earth's surface is a closer analogy than any that occurs to the writer, and avoids the difficulties of either the impact theory or the threadbare volcanic dogma, the latter including the formation of trap-dykes, as suggested by Nasmyth, Proctor and others. In any event, it cannot be explained on the last assumption, since an exact restoration of level which would not cast shadows at lunar sunrise or sunset along a course of hundreds of miles would be almost impossible. The writer pointed this out in a previous paper in POPULAR ASTRONOMY some six years ago.[5]

[2] Annual Report of the Smithsonian Institution, 1903, p. 111, par. 4.
[3] Ibid. p. 112. par. 1.
[4] Cf. POPULAR ASTRONOMY, Vol. XXXI, pp. 4-8 (January, 1923).
[5] "The Impact Origin of the Moon's Craters," POPULAR ASTRONOMY, Vol. XXV, p. 174; (March, 1917).

EXPERIMENTS.

Through investigations in lunar petrography, (from the Greek meaning literally, rock-writing) as he terms it, Doctor Robert W. Wood of Johns Hopkins University has gained experimental proof of the presence of sulphur about certain of the brighter craters on the moon. Some ten years ago Doctor Wood photographed the moon through a quartz lens telescope of about 5 inches aperture, at East Hampton, L. I. (N. Y.) Images were secured that utilised only the light transmitted by a thin film of silver nitrate upon the quartz lens, viz., λ3000—3250, but which plays no part in forming ordinary human vision. Common crown glass is opaque as a stone wall to this short range of the spectrum that lies beyond the violet waves.

When the lunar crater Aristarchus was photographed,[6] a peculiar deposit of dark material was revealed in the winding Schroeter Valley region that was absolutely invisible on photos made with yellow or visual rays (Fig. 5). Although not evident on the latter, it is plainly discernible in the image taken in violet light, wave lengths, λ4000—4500±.

Doctor Wood then proceeded to find out the particular terrestrial mineral that, photographed under similar conditions, would yield the identical actinic reaction of the Aristarchus deposit. He photographed a number of specimens—35 or 40—of light-coloured minerals in ultra-violet light, many of them being of volcanic origin—tuff, lava, etc. A chemical analysis was then made of a chip of yellowish-gray "tuff." It was found that it contained traces of iron and free sulphur. However, photos of rock stained with iron had come out with negative reaction in both violet and ultra-violet light.

There remained the alternative of sulphur, however, and to test the point a very thin deposit of invisible sulphur was formed on the surface of the larger piece. The fragment when photographed by the three different types of light, showed no trace in the yellow picture; only a faint trace in the violet, but in the ultra-violet the deposit came out quite black. "This makes it appear very probable," wrote Dr. Wood,[7] "that the dark deposit around Aristarchus is due to sulphur, or to the presence of rocks containing sulphur. Its immense extent makes me think, however, that it is an actual deposit laid down by an immense blast of gases from the crater."

In an effort to duplicate the experiment, the writer communicated with Dr. Wood, and received filters, photos, etc., which aided him in similar experiments along this line. Subsequently he sent to the house of Chance Brothers, Ltd., glassmakers of Birmingham (England) and obtained a small piece of deep bluish-purple glass about 2¼ inches square. Mr. W. M. Hampton of Chance Brothers, in a letter to the writer, assured him that this glass "is more nearly similar to that used

[6] Scientific American, Vol. CIX, p. 385; (Nov. 15, 1913).
[7] Ibid.

by Professor Wood than the pre-war Uviol glass, the maximum transmission of which is much closer to the visible spectrum." This statement proved correct, and a case of specimen minerals was photographed with a 4x5 camera, a quartz lens substituted in place of the usual anastigmat combination, and a glass cell, in which was cemented the British ultra-violet glass, was interposed between the camera back and the plate. This cell was air-tight, its corners and angles sealed with plaster-Paris, and the ultra-violet window cemented in place with bees-wax. Afterward three or four drops of bromine vapour were introduced into the cell through a glass pipette, and the tiny hole sealed up.

Photography of the mineral specimens with this contrivance yielded the result shown in the photo (Fig. 6, right). Here sulphur, No. 2, came out almost jet black, while zinc oxide, in cell No. 13,—a dazzling white precipitate used as the base of ordinary white lead paint,—evinced a darkness slightly less intense. Furthermore, the cell No. 6, filled with a chip of very white limestone, gave a reaction nearly as dark as zinc oxide, and fully equal to the dark brown kaolin (fuller's earth) in cell 4. These results obviously lead to some very important deductions on the mineral composition of the moon's surface-rock.

Summarizing the results, this fascinating experiment in petrographic photography gives an intimation, not only that sulphur or zinc may be widely distributed through the mineral economy of the lunar surface, but that yet another element, the one that yielded a dark reaction in cell 6, may play a major role, more fundamental and widespread than the first two combined, in forming the feathery Copernican ray system and most of the others on the moon. And that mineral is calcium, or limestone.

### The Universality of Calcium.

Chemically, calcium or Ca is the most widely distributed element in the Universe: glowing in the distant suns of space, such as Capella and Regulus—stars in their stellar prime—and hovering in vast, incandescent clouds about the magnetic vortices known crudely by the term "sunspots," yielding the $K_2$ line in the solar spectrum. Its universality forms one of the romances of astronomy.

The lines of calcium vapour were strong in the spectrum of Nova Aquilæ, a star that blazed out into a first magnitude luminary from a previous obscurity of the 11th magnitude, on June 8, 1918. Their existence was reported by Prof. Isabel Lewis, on the authority of the British investigator Evershed at Kodaikanal Observatory. The latter astronomer announced the presence of fine, dark lines in the nova's spectrum, in a normal position. Yet, under the abnormal conditions of pressure and disruption existing in such stars, all the spectral lines are greatly displaced from their usual alignment. Accordingly, the presence of any element like calcium in a normal position bespeaks an external origin for those lines.

Hence, they doubtless sprang from clouds of calcium gas in the Galaxy illuminated by the fires of the nova's disruption. Prof. Lewis explained it thus: "The existence of these clouds of calcium vapour, lying in the Milky Way would not have been suspected, since in that case the lines of Ca in the star's atmosphere and in the exterior clouds of calcium would have been coincident and have been attributed entirely to a stellar origin. In the atmosphere of a nova, however, conditions are far from normal."

The circulation of calcium vapour in the sun's amosphere has been studied extensively, and it has puzzled astronomers to note the vapour of this comparatively heavy element at relatively quite high levels in that luminary's photosphere. Masses of it congregate about spot groups to form the dazzling white "faculae" there. In 1908 Deslandres isolated the narrow dark central line $K_3$ of calcium, yielded by the upper strata of that vapour on the sun, and photographed the higher levels with it. With a spectroheliograph he was able to isolate, with slits of .03 Angström or greater, either the $K_2$ line or one of the components of $K_3$, "thus obtaining very pure images of each corresponding stratum free from all extraneous light. . The vapour of calcium, which beyond the limb rises *higher than all other vapours*, thus shows us three distinct strata, and if to these we add the ordinary surface of the sun we have *four* layers which are interesting to compare."[8] Deslandres emphasized the prevalence of solar Ca.

Calcium, which occurs abundantly in stellar spectra of many types, with a fecund persistence, exists in the Cosmos here and there in the form of vast clouds, as noted above. It is of the utmost importance in the life economy of our own planet. It enters into the structure of the bones of all vertebrated mammals, and is essential to virtually all forms of animal life save the lower insectivora.

Although its particular function and place in the forming of the stellar bodies and in the Universe is only vaguely and tentatively divined as yet, it is certain, notes Prof. Lewis, that without calcium animal life as it now exists on our planet would be well-nigh impossible.

However, its very universality serves to place in our hands a key to the unlocking of certain lunar mysteries such as the ray systems about Copernicus and Tycho. Besides its wide diffusion through the glowing suns and our own solar star, calcium also forms the strata of our earth planet, rooted deep in the ocean-beds and upthrust into mighty ranges that, flung by igneous upheavals to the majestic heights of our Everests and Jungfraus and Shastas, challenge the Heavens themselves.

Calcium also forms the bone of our bone and the flesh of our flesh, the rib that Scriptural allegory informs us was taken from Adam in

[8] "Progressive Disclosure of the Entire Atmosphere of the Sun," Annual Report of the Smithsonian Institution, 1910, p. 349. (Abstract of discourse delivered at the Royal Institution of Great Britain, Friday, June 10, 1910. cf, *Nature*, v. 85, Jan. 26 and Feb. 2, 1911.)

the dawn of human time to create for him a companion and helpmeet. The coral islands of the Pacific Ocean are wrought entirely from calcium by the polyps that rear the crests of their atolls above the waves that ceaselessly surge about the strands of Clermont-Tonerre, Ponape and Hawaii, itself a vast coral island. The cold Pentelic marble which under the master's hand has been shaped to a splendid nude image of Aphrodite, glowing with a life and passion reincarnate of the lives that went to form her substance in the depths of the ocean, is the product of these humble coral polyps, the Goniopora and other radiates. Truly, Horatio, "there are more things in heaven and earth than are dreamt of in your philosophies!"

### The Organism of the Moon.

The possibility of an organic constitution of the great lunar crater Copernicus, which would cause us to regard it as a huge fossilised marine animal looking down upon our planet, the literal "faithful witness in heaven" that "shall be established forever as the moon" of the 89th Psalm, is the germ contained in the theory proposed by Dr. E. G. Davis, a Kansas astronomer, several years since. Under this weird conception, Copernicus becomes a vast coral atoll, exhibiting tide-gates and terraces almost the counterpart of those in our mundane Pacific Ocean.

The evidence that this investigator brings forward in support of his bizarre conception invests it with such a degree of plausibility as to enforce recognition on a parity with the earlier impact doctrine of Gruithuisen of Germany and the volcanic theory, hoary with antiquity, and unsupported by exact observational data.

Briefly, Dr. Davis sets forth his hypothesis of an organic origin for the lunar craters and their ray systems as follows:[9]

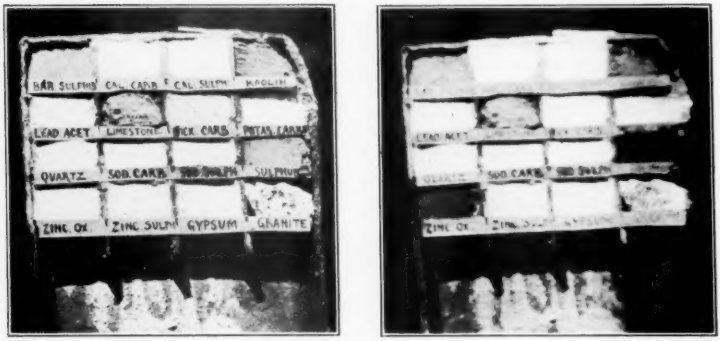
"Tide gates in atolls on the earth are made by seas. And reefs are built only in seas. On the continental lands of the earth, the dry reefs and atolls, or limestone formations, go bail for the seas that once covered these organic structures, but are now gone. The same organic configurations hold good for the continental land upon the moon. In the atolls of the moon, there are 400,000 tide-gates, more or less, which show they have been formed by seas.

"Tide gates in an atoll are as much evidence of the waters which pass through them as are the valves of the heart, for the fluids which it controls.

"In the moon, the atolls and coral systems are world-complete, from the poles, where they began, to the tropics of the moon, where they finished. The great equatorial atolls are formed on the bed of the last seas of the moon; and as we expect from the process, the waters of the moon are gone, since on the earth it is known that coral life in

[9] Art. in Kansas City, Kansas "Globe"; cf. also "Monthly Evening Sky Map," New York, vol. XII, No. 135, (March, 1918).

FIG. 5. Copernican ray system fully developed at full moon. Photo by Ritchey (1901) with 40-inch Yerkes refractor + color screen and Isochrom. plate. These great masses of rays in all their complex branched structure are well brought out in this photo—better than any observer can see them visually. The intricate mass of detail affects the plate to a greater extent than the human eye. Kepler (2.4 : 1.3) is an example of straight, spiked rays. The great sulphur plain lies to right of Aristarchus (2.3 : 0.1) and is revealed only in ultra-violet photos.




IN ORDINARY LIGHT. IN ULTRA-VIOLET LIGHT.

FIG. 6. Photographs of Mineral Substances in ordinary and in ultra-violet light (λ3000-3250). The photographs in ultra-violet light were made by the author by means of a quartz lens and bromine vapour cell transmitting above wave lengths. Note that limestone (cell No. 6) gives a dark reaction, as also sulphur (cell No. 12). Photography of the moon by this method has given similar reactions for certain regions, notably around Aristarchus, and indicates the presence there of limestone, sulphur, zinc and other minerals.

FIG. 7. Photograph of large limestone boulder in full sunlight. A heavy spattering of sulphur was deposited over the left-hand portion but is practically invisible.

FIG. 8. Photograph of the same boulder taken with the ultra-violet filter. Notice the spattering of sulphur just beneath the cross-shaped shadow, 1 inch from the left side of the picture.

forming its product limestone, or bone, in seas, chemically destroys water in the action. The carbon dioxide ($CO_2$) evolved by this lungless form of life, in its act of living unites with the water in the protoplasm of its cells, forming the animal carbonic acid—$H_2CO_3$. Calcium in the protoplasm of the cells coming in contact with this acid is precipitated as calcium carbonate, $CaCO_3$, bone or limestone from the cells.

"Look at the atoll Copernicus. It has two tide gates; one in the north and one in the south (See Fig. 3), agreeing in direction with the tides on the moon,[10] and the directions of the tide gates of all the other atolls seen in the photograph, for 700 miles. Its rim reefs are seen to be from the outer rim of the atoll and are short on the sides, because the water soon got too deep, and long on the ends, because the water on the reefs was shallow. Atolls are seen to have grown in its tidal gates. One lagoon reef is seen started at the northern edge of the lagoon.

"The coral seed carried out by the currents from its tide gates into the ocean has seeded the ocean bed with calcium seed for 500 miles; crystallised and forming with its wreaths the great ray system which gleams like a sun at the noon of lunar day.

"Copernicus is thus a fossil coral island, with rim reefs, inner rings, tide gates, central lagoons, central peaks, small lagoons and tide gate atolls, with all the surrounding attendant features of a great equatorial atoll—a coral island formed refulgently in the tropics of the moon."

An explanation for the peculiar dark streaks and deposits observed in the equatorial regions of the moon and interlaced with the bright rays is furnished by Dr. Davis, who concludes: "Coral island formation explains the heavy ancient polar liming seen on the moon, and the last sea beds with the latest atolls, together with the humus or dark soil of the planet, in the low equatorial regions where they and sedimentation ceased simultaneously. Our humus and dark soil is being hurled into the Gulf of Mexico by the Mississippi at the rate of a cubic mile a year, and by every river of the world to the present lowlands of the earth. Not an ounce of this ever returns. Coral island formation and composition explain the wonderful crystallization and marble whiteness seen upon the moon; and completed sedimentation explains the dark band of humus seen in its central belt.

"And so surely as the great sheets of strata of organic limestone, and the dark soil of our globe are the chemical sequella of bones and flesh, so also, these like deposits now seen on other worlds (moon, Mars, etc.) depict to us the completion of sedimentation, and the like remains on

[10] In this connection, note that the major north-and-south Copernican ray shown in Fig. 3 (1.1 and from 0.8 to bottom of photo) leads directly out from the northern tide-gate of its great focal crater—a most significant circumstance. The same condition has been observed among terrestrial coral atolls;—the washing out of calcareous matter from the tide gate and its deposition over the oceanic floor.

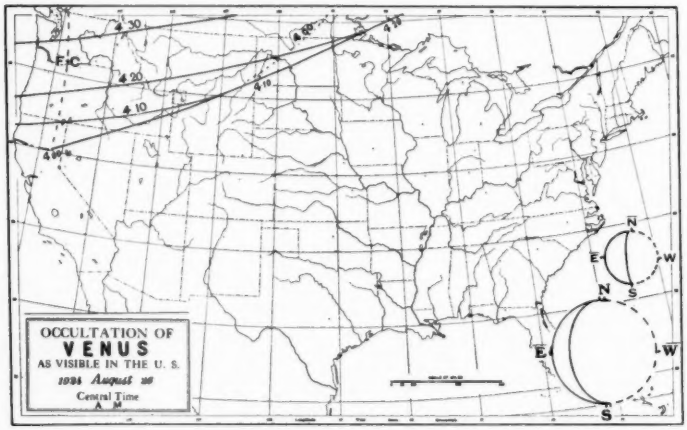
these globes of the flesh and bones of organic life. Thus, "the whole earth (or moon) shines with a clear light!"

Kansas City, Missouri.

## OCCULTATION OF VENUS 1924 AUGUST 26.

By WILLIAM F. RIGGE.

This occultation of Venus of 1924 August 26 would be one of the finest on our list, fairly rivaling that of 1923 January 13, but for two unfortunate circumstances. First, its visibility is confined to the extreme northwest of the United States, and secondly, it occurs between 4:00 and 4:30 A. M., Central Time, or between 2:00 and 2:30 A. M.,




Pacific Time. The point FC on the adjoining map is that of First Contact, the first place on earth to see this occultation begin. The moon will then be rising at that place, as also along the dashed line passing through it. This will happen at 3:51 A. M., Central Time. In 9 minutes places on the dotted line 4:00 will begin to see the planet eclipsed. The reappearance will take place at 4:10, 4:20, 4:30, on the curves so marked. On the Limit Line the times 4:00, 4:10, 4:20, indicate the grazing contacts. Places south of this line will see only a close conjunction. The degree of closeness may be estimated somewhat when we know that at Omaha Venus will approach the moon's disk within 0.15 of the latter's diameter, at 4:03 A. M., S 3° E, B 48° R. The moon will be a beautiful crescent, moving with its bright limb forward, 26.2 or —3.3 days old, while Venus will be nearly half-full.

# REPORT ON MARS No. 27.

By WILLIAM H. PICKERING.

## General Information and Instructions.

This report will be devoted mainly to giving more or less technical information and suggestions to other observers, some of whom may be beginners. The apparition occurring this year is a notable one. Opposition occurs on August 23, but on account of the eccentricity of the Martian and terrestrial orbits the planet will be nearest to us August 22 $12^h$ G. M. T. or at $7^h$ in the evening Eastern Standard Time. It will then be nearer to us than has been the case since before 1800, or than will again be the case until after the year 2000. The next nearest opposition occurred eighty years ago in 1845, when the planet was only slightly more remote. We shall this year approach it within 34,630,000 miles. A question of one or two million miles will however make no particular difference to astronomers, but the thing that really interests them is that the planet will stay near us for a very long interval, so that we can watch it through a very long portion of its year. In 1916 we passed Mars when it was near its aphelion, and on only one day in February did we get to within 62,680,000 miles of it. This year we shall be nearer than that from June 9 to November 1 inclusive, or for 146 days. During all this interval we shall be able to scan its surface to very great advantage.

Unfortunately for northern observers the planet will be pretty far south of the celestial equator, although not as far as at the last apparition. It will reach its farthest south this year on March 13, $-23°.6$. It will then advance steadily northward to $-14°.7$ on July 11, it will again turn south to $-18°.4$ on September 8, and then rapidly northward to $-11°.9$ on November 1, and to $+2°.9$ at the end of the year.

After June 21, for that portion of the Martian year following $\odot$ $203°.3$, and corresponding on Mars to the middle of October, the planet will present a larger disk than it has at that same season for many years. We shall therefore see it during the interval of its late autumn and early winter particularly well. Its maximum diameter on August 22 will be $25''.1$. It passes its autumnal equinox for its northern hemisphere, $\odot$ $180°$ according to the Ephemeris on May 13, and its winter solstice $\odot$ $270°$ on October 5. We shall consequently get a better view of the southern hemisphere of the planet than we have had for many years, the latitude of the center of the disk ranging from $-16°$ to $-21°$ for the five months, June 1 to November 1, when the planet is nearest to us.

In Report on Mars No. **15**, POPULAR ASTRONOMY 1916, **24**, 236, we explained the proper use of the Ephemeris as published in the *Nautical Almanac*. Since Mars is to be so near us this summer, it is possible that a number of amateur astronomers may wish to observe it, who will not have access to that Report, and will not know the best way to record their observations. It has therefore seemed to me desirable to rewrite certain portions of it, with such changes as have been rendered necessary by alterations in the *Almanac*, and such revisions and improvements as have occurred to me in the meantime. For any really accurate work on Mars a copy of the *Almanac* is absolutely neeessary.

But before proceeding to consider the observations a few words may be said regarding the most desirable kind of instrumental equipment. For Planetary as distinguished from Sidereal astronomy, certain requirements are of importance. Our knowledge of Mars has now reached such a state of completeness, that only under exceptional circumstances can a telescope of less than 5 inches aperture be of much use. For the same amount of money, if less than a thousand dollars is available, better results can certainly be obtained with a reflector than with a refractor. On the other hand, however, a reflector is much the more troublesome of the two, on account of the necessity of occasionally silvering the mirror, and of its variations in shape due to changes in temperature. For larger instruments, we find in practice, that Mr. Phillips usually prefers an 8-inch Cooke refractor to a 12-inch Calver reflector. At the Lowell Observatory they prefer a 24-inch refractor by Clark, with an aperture reduced sometimes to as little as 12 inches, to a 40-inch reflector by the same maker. Heretofore Professor Douglass has used an 8-inch Clark refractor. This year he is to use a 40-inch Brashear reflector. It will be interesting to see which instrument in his hands gives the better results. A large aperture is particularly desirable for the study of color effects, on account of the greater brightness of the image. This applies chiefly to Mars and Jupiter however.

An equatorial mounting and satisfactory driving clock would be considered indispensable by most observers, yet Mr. Wilson has secured excellent drawings in the past without a clock. It would, however, be hopeless to attempt measurements without it. For lunar work provision should be made to slow its rate appreciably, and some arrangement of gears, without using a screw, should be employed to provide for motion in declination. In moist climates a wooden dew cap extending a short distance down the tube of the telescope must be provided. With apertures of over 10 inches a cat's eye diaphragm, which can be manipulated from the eye-end, should be placed over the objective, to regulate the aperture in accordance with the quality of the seeing. Finely divided circles are of no use in Planetary astronomy, but a rough graduation to degrees will occasionally be found convenient. A position circle at the eye-end is necessary for accurate work.

For low latitudes a total reflection prism should be used for all work, and the observer must gradually accustom himself to seeing everything right for left. The best seeing always occurs near the zenith, and without the prism this part of the sky is entirely eliminated from observation. Moreover the trouble from the flying specks within the eye is much reduced if we look horizontally instead of upwards. A filar micrometer is of course necessary for some investigations. For the study of the finest detail, there is no question but that a negative eye-piece is superior to a positive one. This is chiefly because, with the latter, dust and irregularities of surface on the field lens interfere with the view. A Tolles' single lens eye-piece is better than either for showing faint contrasts in difficult detail, and should certainly be employed for this work. It also has a larger field. It has the disadvantage, however, that since its focus lies within the glass itself we cannot employ a reticule with it.

For small apertures a magnification of 40 or even 50 diameters per inch of aperture may be employed, if the seeing is good enough. I have myself used a power of 660 on our 11-inch refractor to advantage, when the disk of the planet was small. This was merely for drawing out lines however. In a search for fine detail, or faint contrasts, a magnification of 430 or even 330 was preferred. Most observers with large instruments confine themselves chiefly to powers of 400 to 450. We are provided this year with Tolles' eye-pieces of 300, 400, and 600 magnification, to be used in accordance with the object and the character of the seeing.

Considering that the instrument equipment is already provided, we will now consider what preparation should be made for our planetary studies. In making drawings of Mars it is very desirable before any attempt at sketching the details is made to have a disk properly outlined on paper, the gibbous shape being correctly shown, and the positions of the poles marked. Some observers are in the habit of making all their drawings of the planet, from the beginning of the apparition to the end, of exactly the same size. This has the serious disadvantage that at the beginning and end the scale of the drawing is much too large, while at opposition it is too small to show properly all that can be seen. Much the better plan is to draw on a fixed scale, of let us say either 3 millimeters, or a tenth of an inch, to one second of arc. The only disadvantage of this plan is that if we wish to copy certain of our drawings of the planet made near opposition, so that they shall all be of the same size, it is a little more troublesome to do so. This difficulty is insignificant however, and we have used this plan successfully here since 1912. On account of the excellent seeing that we enjoy, we have adopted a scale of 4 mm. to the second, but in most localities 3 mm. will be large enough. The larger the drawing, the longer it takes to finish it, which is a distinct disadvantage in the case of a rapidly rotating planet. It is the custom of the writer to enter all his draw-

ings on the right hand pages of a record book devoted exclusively to this planet, since it is then more convenient to compare them with one another. We record the date at the top of each page, and of each figure, and beneath the latter the time of beginning and ending the drawing of the outlines, also the time of finishing the shading, the magnification, the quality of the seeing on the Standard Scale, and the aperture when a change from that usually employed occurs. Then follow the computed results, which we shall next describe, and which are entered in ink.

In order to explain more clearly how the disk should be drawn, we will give an example of what we believe to be the best method of procedure. Let us suppose that we wish to make some drawings of the planet at the end of June. Since we may have cloudy weather on any particular night, and the planet changes its size and shape very slowly,

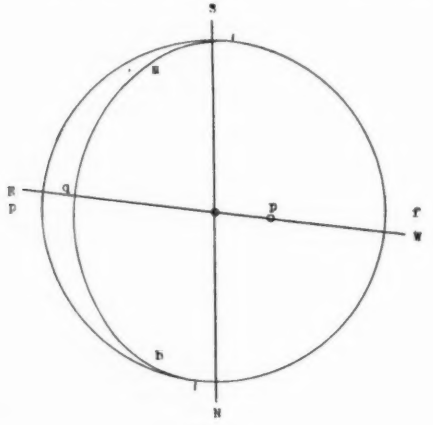



FIG. 1.

we will select some time such as Greenwich midnight on July 1, and compute our disk for that instant. This computation is entered in ink on the margin of the record book. Consulting the *American Ephemeris* for 1924, p. 629, we find that the apparent diameter of the planet will be 17″.56 or 52.68 millimeters upon our adopted scale. If we prefer tenths of an inch the diameter will be 1.76 inches. We will now draw a circle of this diameter, and a vertical line passing through its center to indicate the south and north poles of the planet. Again consulting the Ephemeris we find that $q = 1''.59 = 4.77$ mm., $Q = 252°.1$, and $P = 349°.0$. Then in order to locate the phase axis we have $Q + 90° - P = -6°.9$. Lay off this angle by means of a protractor from the north pole, towards the east or preceding side, since it is a minus quantity, as shown in Figure 1. On Mars east is defined as on the earth, and corresponds to west on the moon, or in the sky. A diameter

through this point will be the phase diameter, and a perpendicular to it the phase equator EW. From the eastern end of this latter before opposition, or from the western end afterwards, lay off the distance $q = 4.77$ mm.

While we cannot draw an ellipse with dividers, yet if the excentricity is not very great, as in the case of Mars, we can approximate to it sufficiently nearly for any drawings we may have occasion to make. The maximum possible ratio of $q$ to the diameter $d$ for Mars is 0.15.

TABLE I.

FACTOR FOR DRAWING ELLIPSES.

| $q/d$ | Factor | $q/d$ | Factor | $q/d$ | Factor |
|---|---|---|---|---|---|
| 0.00 | 1.000 | 0.05 | 1.08 | 0.10 | 1.17 |
| .01 | 1.015 | .06 | 1.10 | .11 | 1.19 |
| .02 | 1.03 | .07 | 1.115 | .12 | 1.215 |
| .03 | 1.05 | .08 | 1.13 | .13 | 1.24 |
| .04 | 1.065 | .09 | 1.15 | .14 | 1.265 |
| | | | | .15 | 1.30 |

In Table I is given the factor by which we must multiply the radius of the planet, in order to obtain what we may call the phase radius, the radius with which we can draw the middle two-thirds of the terminator. The remaining one-sixth near each phase pole we must finish by hand. This however is easily done since we have the original circle of the disk to guide us. Returning to our drawing of July 1 we find that the ratio of $q/d$ equals 0.09, and by the table the corresponding factor is 1.15. Multiplying our semi-diameter 26.34 mm. by this factor we obtain 30.3 mm. From the point $q$, Figure 1, lay off this distance $qp$ on the phase diameter, and with $p$ as a center draw the middle section $ab$ of the arc of the terminator. Finish by hand or with a celluloid curve. The maximum deviation between the circular arc drawn by this method and the true elliptical curve is 0.015 of the radius, and lies at about 40° from the phase equator, the radius of the circular arc being a little too short at this point. This method is quicker, and distinctly more accurate than the well-known method of drawing an oval by means of circular arcs. When the ratio $q/d$ does not exceed 0.05 we may draw the whole terminator with a radius equal to that of the planet. The maximum deviation from the ellipse, however, will then be larger, reaching 0.03 of the radius between phase latitudes 60° and 70°.

The phase drawing is now complete, but when a continuous series of drawings is being made, it is a good plan to copy in the snow cap from one of the previous drawings before beginning to work. This is particularly true of the northern snow cap when it is small, and changes but little from night to night. This saves time at the telescope, and if the drawing is incorrect, it is a simple matter to change it. The method employed in making drawings is described in full in Report No. 9, and need not therefore be repeated here. The writer has a few extra copies of this report which he can furnish to those who

would really like to make use of it, and cannot otherwise see it. In order to locate the planet's axis on the drawing with accuracy, a position circle is necessary. We first let the planet trail, and set the thread parallel to its motion. Then we read the circle, and add $90° + P$ as given in the Ephemeris. This gives the azimuth of the axis. Without a position circle we may orient roughly by the north polar cap direct, when this is visible.

In order to obtain readily comparable drawings of the planet, it is desirable that an effort should be made to secure them when certain fixed longitudes are on the central meridian. Twelve longitudes 30° apart have been selected beginning with $\lambda = 0°$. At the close of each apparition the alternate ones 0°, 60°, 120°, etc. are published. In order to determine at what time the drawings should be made in order

TABLE II.

TIMES OF TRANSIT FOR SELECTED MERIDIANS.

| Merid. | Hour | Merid. | Hour | Merid. | Hour |
|---|---|---|---|---|---|
| ° | h m | ° | h m | ° | h m |
| 30 | 2 03.1 | 150 | 10 15.6 | 270 | 18 28.0 |
| 60 | 4 06.2 | 180 | 12 18.7 | 300 | 20 31.1 |
| 90 | 6 09.4 | 210 | 14 21.8 | 330 | 22 34.2 |
| 120 | 8 12.5 | 240 | 16 24.9 | 360 | 24 37.4 |

to have these meridians central we shall make use of Table II. This table is based on the supposition that the same point transits the central meridian of the planet on successive nights after an interval of 37.4 minutes. Owing to the relative orbital motions of Mars and the earth this quantity is liable to slight fluctuations, but the table gives average results which are near enough for all ordinary purposes. Let us suppose that we wish to know at what time longitude 240° will transit on July 1. From the table we find that the hour corresponding to longitude 240° is $16^h\ 24^m.9$. Turning to the Ephemeris we find in the next to last column on page 629 the number $2^h\ 50^m.4$. Adding these and subtracting $5^h$, if we use Eastern Standard Time, we learn that longitude 240° will transit the central meridian of the disk at $14^h\ 15^m.3$ E. S. T. In case our result had exceeded $24^h$, as it is liable to do for the higher longitudes, we should have had to take the hour from the previous day in the Ephemeris, and subtract $24^h$ from our final result.

Before we begin our observations for the year we always compute a private ephemeris for our station, a portion of which is shown, as follows:

| July 1 210° | | July 4 180° | |
|---|---|---|---|
| h | m | h | m |
| 9 | 21.8 | 7 | 18.7 |
| 2 | 50.4 | 4 | 45.9 |
| 12 | 12.2 | 12 | 04.6 |

The successive lines give the dates, the longitudes of the central meridians desired, the corresponding hours, taken from Table II less $5^h$ cor-

rection for Eastern Standard Time, the hours for the dates taken from the *Almanac*, and the corresponding hours at which the drawings should be made. The interval between the times taken from the *Almanac* is $73^h\ 55^m.5$. Dividing this by 36 gives us the interval $2^h\ 03^m.2$ required by the planet to revolve 30°. Adding this to $12^h\ 04^m.6$ gives us $14^h\ 07^m.8$, the time that longitude 210° would reach the central meridian on July 4, which we might of course have computed directly. The difference between this last time and $12^h\ 12^m.2$ divided by 3 gives us $38^m.5$, which shows us how much later the same meridian transits on successive days. This figure differs by several minutes in different parts of the apparition. We are now prepared to construct our private ephemeris, of which it will only be necessary here to give four dates. The intermediate dates in the columns are obtained by simply adding the $38^m.5$. The successive hours on the same night are obtained by adding the $2^h\ 03^m.2$.

| July | E. S. T. | Long. | E. S. T. | Long. | E. S. T. | Long. |
|---|---|---|---|---|---|---|
| | h m | ° | h m | ° | h m | ° |
| 1 Tuesday | 12 12.2 | 210 | 14 15.4 | 240 | 16 18.6 | 270 |
| 2 Wednesday | " 50.7 | " | " 53.9 | " | " 57.1 | " |
| 3 Thursday | 13 29.2 | " | 15 32.4 | " | 17 35.6 | " |
| 4 Friday | 12 04.6 | 180 | 14 07.8 | 210 | 16 11.0 | 240 |

We will suppose that having now obtained our drawing, which will not in general have been secured at exactly the required time, we wish to know the longitude of its central meridian. The question immediately arises at what time should we say that the drawing had been made. Heretofore it has been the general custom to take the mean of the times when the insertion of the details was begun and finished, and before the shading was begun, and call this the time for which the central meridian should be computed. Another suggestion is that the proper time is that at which the drawing is begun. Since the planet rotates at the rate of 1° in 4 minutes, and a drawing may sometimes require as much as 20 minutes or more to construct all the details, the question

TABLE III.

MULTIPLICATION TABLE FOR *r*.

| | ° | | ° | | ° |
|---|---|---|---|---|---|
| 1 | 14.62 | 4 | 58.48 | 7 | 102.34 |
| 2 | 29.24 | 5 | 73.10 | 8 | 116.96 |
| 3 | 43.86 | 6 | 87.72 | 9 | 131.58 |

is evidently one of some importance. It is likely that the rule would vary somewhat for different individuals, but if the plan of drawing suggested in Report No. 9 is followed, it is probable that the last suggested time is the best one to adopt. The matter will be further discussed in another report. In case we use Eastern Standard Time, Greenwich midnight occurs at 7 P. M. We must then multiply the number of hours and tenths that has elapsed since then by 14°.62, the average number of degrees that Mars revolves in one hour as seen

from the earth. This we may most readily do by means of Table III. Add to this the number given under Central Meridian in the Ephemeris, and we have the required longitude. This computation we will also enter on the margin of the page. Under each drawing we should enter in ink the longitude of its central meridian, underscored, the solar longitude ⊙ corresponding to the time at which the drawing was made, and which for Greenwich midnight of July 1 is given in the Ephemeris as 209°.35, the Martian Date corresponding to this number, taken from Report No. 10, the diameter of the disk in seconds, and the declinations of the Earth and Sun $D_{\oplus}$ and $D_{\odot}$, as seen from the planet, all taken from the Ephemeris.

Besides the larger drawings, we find it often useful near the time of opposition to have a series of smaller disks, some two inches in diameter, with the phase laid off approximately upon them. These we use when the conditions are unfavorable, or when we wish to depict some special feature only. We sometimes wish to know how distant the planet is from the earth in miles. This is readily obtained in miles by multiplying the Light-Time given in the second column of the Ephemeris by 11,180,000, which is the distance traversed by light in one minute of time. To find the distance in kilometers multiply by 18,000,000. In order to determine the local Martian Apparent Time at which any event occurs upon the planet, such as the disappearance of a canal under a cloud, we correct the longitude of the Central Meridian by the number given in the column $A_{\odot} - A_{\oplus}$, both taken from the Ephemeris. Correct for the time of observation. This gives us the longitude on the planet at which noon is occurring at the given time. The difference between this result and the longitude of the canal, or other marking, gives us the number of hours that the event occurred before or after Apparent Noon. We sometimes may wish to describe the darkness of a given area on the planet. For this purpose a scale of ten parts has been employed, where 1 represents a very phenomenal darkness, such as might occasionally be found in the northern portion of the Syrtis, 3 the usual darkness of the maria, 7 the usual brightness of the desert areas, 8 and 9 the brightness of clouds along the limb, and 10 the brightness of the polar caps when they shine, as they occasionally do, with an intense white glare. These numbers may be placed directly on the drawings, and would then be of assistance should copies of them be desired for reproduction.

We are now aware that the position of the axis of Mars hitherto adopted in the *Almanac* is in error by nearly 3°, as is shown in Report No. 26. Further evidence on this matter will be furnished in our next report. Until the Ephemeris can be changed to meet the new conditions, we shall publish curves and formulae which will enable each observer to correct it, so as to give him accurate results to apply to his own observations of latitude and longitude. We are thus following the precedent we formerly set in a small way with regard to the angu-

lar diameter of the planet, prior to the time when the Ephemeris could be changed to agree with the better determination.

### Publication of Drawings.

An invitation is hereby extended to all observers, whether heretofore members of the International Society of Observers of Mars, or not, to forward any drawings of the planet that they may secure this year and wish to have published, to the writer, in Mandeville, Jamaica, B. W. I. If their drawings are inferior to the least satisfactory of those published in Report No. 25, Popular Astronomy 1923, **31**, 213, it would be hardly worth while to send them. Care should be taken to draw only those features of which one is perfectly certain. A mere momentary glimpse of a lake or canal is no evidence at all that it really exists. We draw here only those canals that we can hold steadily and surely, and give no weight whatever to a canal that we simply imagine that we see. We hold it equally objectionable to take a map of Mars to the telescope, and look for known canals on the planet to enter on our drawings. The canals vary from year to year, some appearing one year and some another. Also they may change their shapes and azimuths upon the disk. Therefore a canal drawn under the influence of a map may entirely misrepresent what really exists on the planet. A drawing to be of any use whatever should contain only the observer's own impressions.

As mentioned in previous Reports, each observer is expected to send in six drawings, but a smaller number will be accepted. These drawings should be made with the central meridian coinciding as closely as possible with longitudes 0°, 60°, 120°, 180°, 240°, and 300°. It is recommended that the drawings be made between the middle of July and the first of October, but those made earlier or later will not be ruled out. Sufficient information should be given with each drawing to enable the writer to fill out a table like Table I of Report No. 25. This should include a statement whether the instrument employed was a reflector or a refractor, its aperture, and the magnification employed, the quality of the seeing on the Standard Scale, the date of the drawing, the hour, the kind of time used, or a reduction to Greenwich, and the computed longitude of the central meridian.

The publication of the drawings made at the apparition of 1922 has been seriously delayed by the fact, that although most of the observers sent in their drawings very promptly, yet one or two of the most prominent ones delayed forwarding them to me until this past winter, since which time I have been so fully occupied with other matters, that it has been quite impossible to make the comparisons necessary to decide which drawings to publish, and which ones to omit. This comparison is a rather laborious process, involving the identification and study of all the canals shown upon each drawing. It is expected to publish the drawings some time this year, but it is hoped that observ-

ers will be more considerate in future, since the delay of a few prominent ones enforces the delay of the publication of the work of all the others.

### Suggested Observations.

It is now suggested that the most important work that can be done on Mars at the coming apparition, besides making frequent drawings of detail, is for those who possess filar micrometers to make as many determinations as possible of the latitudes of the thirteen points described in Report No. 26. The main object of these measures is not so much to confirm the new position of the axis, although they will serve for that purpose, as it is to determine the nature of the shifts in location of these markings,—how far they are seasonal, and how far irregular, in the nature of a week to week shift in position. There is no question now but that the shifts occur, and that their extent is small, hardly exceeding the width of a wide canal, and it is for this reason that independent observations are necessary to confirm and measure them.

The micrometer is particularly adapted to this work, since while its systematic deviations for fine planetary detail are large, its accidental deviations are small, as compared with drawings. We do not care so much what is the true latitude of the point under consideration, as we do to know the extent of its shift in latitude. If a micrometer is not available, or even if it is, a determination of the latitude by means of drawings made as described in Report No. 22, under Shifting Surface Detail, is very desirable. Drawings made in the manner there described give much more accurate determinations of latitude than drawings made in the usual manner. Determinations of longitude may be as accurate as those of latitude, but that question is not yet settled, and it is certain that if made by means of transits of the central meridian, they require more time to secure them. Observations of latitude made at stations remote from Europe and America, such as Japan and Australia would be particularly valuable. The writer will be glad to publish any such determinations as are made.

The particular object in studying these small shifts of position is to throw whatever light we can on the nature of the lakes, canals, and other markings on the planet. It seems unlikely that a canal shifting its location through let us say 150 miles can owe its origin to vegetation growing along the sides of an irrigating ditch or covered aqueduct. Ditches can hardly move, although parallel ditches suitable for double canals might be constructed. That however complicates the problem, which already seems rather improbable, with its necessary gigantic pumping engines. If the canals are shower tracks, we should expect them to shift about irregularly, but why do they shift so little? The great problem of Mars is undoubtedly the explanation of the canals and lakes, and anything that we can do to help elucidate that problem is clearly of the first importance.

Another fact bearing on this question which it would be of interest to observe, especially about opposition, is whether the canals are most marked before or after passing the central meridian. If before, that would imply that they are developed at night perhaps by passing showers, if after, that implies that they are developed by day, the sun perhaps causing a thawing of the ground. They shift and change so rapidly in some cases, that it may well be questioned if they are any of them due to vegetation. At past apparitions at least two reliable observers have thought they perceived flashes of light coming from certain areas on the planet. These flashes were probably optical illusions due to eye strain. Nevertheless should any observer feel reasonably sure that he had seen something of the sort, he must not hesitate to communicate it, and if it should be confirmed by one or two other observers, seeing it at the same time in the same part of the planet, the matter would then become of some general interest.

### Miscellaneous Phenomena.

Last year's small northern polar cap probably disappeared in March, ⊙ 150°, the middle of the Martian August. It was not seen here, but the northern snow storms should have begun before that. The climatic conditions on Mars are so irregular, and vary so greatly from year to year, that a variation in the solar longitude ⊙, amounting to 20° or even more, is not at all unusual. This would correspond to about forty terrestrial days. Snow was seen in March stretching along the northern limb, but since the northern pole was turned away from us, and the planet was remote, diameter only 7″, little of interest was detected there. The snow may be visible as a long narrow band until June or July. Considerable irregularity should develop in May and June, affecting the northern detail, notably Acidalium. If not too near the limb, marked hourly changes may also be detected. Many cloud projections were seen upon the snow between ⊙ 178° and 211° in 1922, and should be looked for this year. The corresponding terrestrial dates are May 9 and July 4. The southern pole has been enveloped in cloud, but is expected to clear in April, early Martian September. The polar cap will begin to grow smaller in June, the end of Martian September, but will probably remain visible throughout the year when favorably situated for observation.

During April and May white clouds may conceal some of the dark portions of the disk, such as the Syrtis and Protei regions. The green color of the southern maria has already been detected, and will continue visible until opposition, the middle of the Martian November. For a study of the Martian colors the best artificial light to employ is a tungsten lamp of 20 to 40 watts, shining through a sufficient number of pieces of light blue glass, so that the illumined white paper, seen through a hole in blackened cardboard placed upon it, shall appear of both the same brilliancy and color as the polar snow cap. This test can

of course only be applied when the polar cap is quite free from the yellowish clouds which conceal it during the winter season. The narrowest canals should be seen at the end of May, the end of the Martian September. This is perhaps the most promising time to detect their duplication, if it really exists, although at the end of August the angular diameter of the planet is twice as great. In 1892 the darkest portion of the Syrtis exhibited a very striking transformation in shape, size, and color at ⊙ 214°. This was in connection with a marked development of Pandora, a canal connecting it at that time with the southern polar cap, and was followed immediately by a very extensive cloud formation, concealing much of the surrounding region. It occurred following a decided decrease in the size of the southern polar cap. The corresponding date this year will be July 9. There is no reason to expect a repetition of the occurrence on that date this year however, but the Syrtis should be carefully watched whenever visible, during June and July, especially in Japan and Australia, at times when it will be invisible to the more numerous American and European observers.

An interesting change in the location of the northern boundary of the southern maria between the Syrtis and Elysium will take place this year. In ⊙ 150°, Martian August, the northern boundary will be at Libya, latitude —6°. As the apparition progresses Libya and Aethiopis will gradually darken, as was first noticed by Perrotin over forty years ago. A new northern boundary will now be seen at Nepenthes, in latitude +15°. Both boundaries will be clearly visible for several months. and then the southern one will fade out, in early Martian November, and only the northern one will be left. The change should take place between terrestrial June and October.

In 1922 on July 4 the Furca at ⊙ 185° presented its usual appearance for the previous four apparitions, which is I believe to the normal eye that of a solid dark quadrilateral at the end of Sabaeus, Aryn being invisible. The next night it had lengthened in longitude by about 200 miles, and was therefore very carefully drawn. The night following it was if anything shorter than usual, but Aryn had now appeared as a short notch. Cloudy weather followed, but July 9 the notch was deeper and unquestionable, although by no means as distinct as during the apparition of 1892. It was seen even better in August, but by September the notch had disappeared. If the same sequence of events should occur this year, Aryn will appear the latter part of May.

It is expected that Amenthes will again become visible this year, and Nepenthes disappear. Observers should be careful to distinquish Amenthes from Triton. Amenthes begins on the western side of Hesperia, while Triton begins on the eastern. The northern part of Amenthes coincides very closely, if it is not identical with Thoth. The former was first suspected in 1922 at ⊙ 154°, and was clearly seen at ⊙ 173° and at 193°. These longitudes correspond in the present year

to March 26, May 1, and June 4. At 173° Nepenthes disappeared, but reappeared a few days later. At the following presentations in the succeeding months Amenthes was always seen, while Nepenthes had vanished. Amenthes appears to be associated with the southern polar cap, while Nepenthes is associated with the northern, and with the snow storms that immediately succeed it.

Mandeville, Jamaica, B. W. I., April 5, 1924.

## OBSERVATION OF THE HEAVENS.

By FREDERIC R. HONEY.

*(Continued from page 174.)*

### Observations of the Planets.

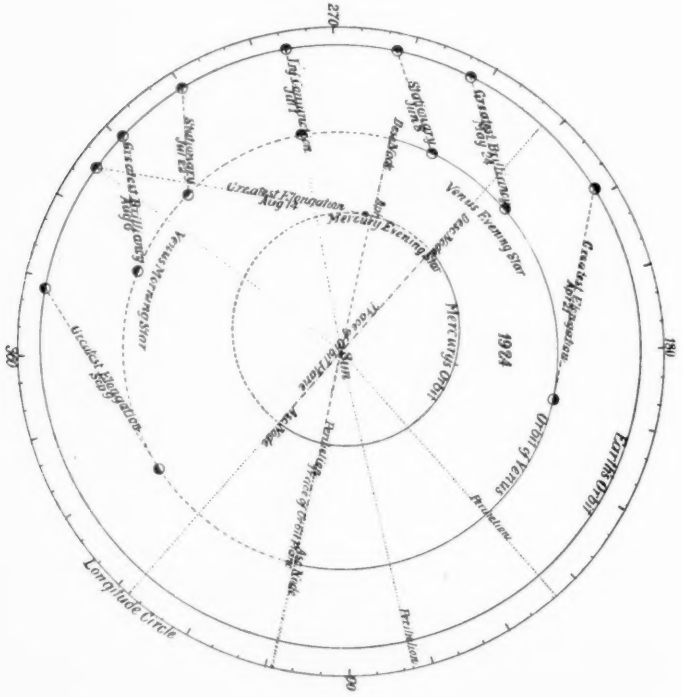
Observers of planetary configurations have noted that Venus comes to inferior conjunction this year on July 1, thus dividing the year into two equal parts; for the first six months, when the planet is rapidly approaching the earth, and apparently increasing in diameter, as evening star; and for the latter half of the year, when it is as rapidly receding from the earth, and decreasing in apparent diameter, as morning star.

A series of inferior conjunctions, to which the one illustrated in the accompanying plot belongs, is interesting, because the conjunction recurs at intervals of very nearly eight years, i. e. alternate leap years. There are thirteen sidereal periods, or five synodic periods, included in eight tropical years. Multiplying the sidereal period by 13, and the synodic period by 5, the former gives as a result $0.61521 \times 13 = 7.99773$; and the latter $1.59872 \times 5 = 7.9936$. The sum of the synodic periods falls short of eight years by a very small fraction of a year (0.0064). The following are the dates of inferior conjunctions in July at eight year intervals for the past half century, beginning with the conjunction of 1868—July 16, 13, 11, 9, 7, 5, 3, and 1.

The orbit of Venus has such a small eccentricity that it is practically a circle whose centre is indistinguishable from the sun in the drawing; and the planet's velocity in its orbit is nearly uniform. As a consequence the phenomena of "greatest elongation," "greatest brilliancy" and "stationary," are repeated in nearly equal corresponding intervals in inverse order on each side of inferior conjunction.

If the trace of the plane of the planet's orbit, connecting the ascending and descending nodes, be produced each way, it intersects the earth's orbit at points which the earth reaches in the months of June and December; and the drawing illustrates the well known fact that a transit of Venus is possible only during one of these months.

Also the plot shows that if the trace of the plane of Mercury's orbit be produced, it intersects the earth's orbit at points which the earth reaches in the months of May and November; and as a transit of Mercury can occur only when the planet is at or very near the ascend-



ing or descending node, it is possible only in one or other of these months. A comparison of the longitude of the descending node, with the longitudes of the earth and Mercury this year on May 7, shows the conditions which determine the transit.

Transits may occur at either node at intervals of 7, 13, or 46 years.

The latter period, it will be noted, is the sum of one 7 year period, and three 13 year periods.

On account of the great eccentricity of the orbit the distance from the planet to the sun when it is at or near aphelion is very much greater than when it is at or near perihelion. It is, therefore, seen to very good advantage as evening star on August 14 when at the greatest elongation this year.

## REPORT OF THE COMMITTEE ON PHYSICAL OBSERVATIONS OF THE PLANETS.

*Below appears the report prepared by the Committee on the Physical Observations of the Planets, of the American Section of the International Astronomical Union, for the meeting of the Union at Rome, May, 1922. It is here published for the first time and substantially in its full original form. The few remarks that have been added are of the nature of explanatory details intended to clarify or slightly extend a few points of the report to facilitate their practical application by the observer wishing to put in practice suggestions it contains. It is believed that owing to the approaching opposition of Mars, the publication of the report at this time will be of interest and may prove of value and assistance to some of those interested in planetary observation. Its publication here has the approval of the American Section of the International Astronomical Union.*

*May, 1924.*

C. O. Lampland,
E. C. Slipher.

*(The introductory note below was written by the late Professor Barnard at the time of the submission of the report.)*

The following Report of the Committee on Physical Observations of the Planets is herewith respectfully submitted. The greater part of this report is due to Messrs. Lampland and Slipher, whose work on the planets, both visually and photographically, will make their remarks of special value.—E. E. Barnard.

The extent of the field of the physical observations of the planets we interpret to include practically all researches—the observations and their interpretations—relating to these bodies, except the problems dealt with by theoretical astronomy. The field is, consequently, a broad one. With the means and methods developed in recent years the opportunities seem to be especially promising for making important additions to earlier work as well as new contributions to our knowledge

of the planets. The variety of topics suggested in the following notes may at first sight appear to lead to a program too comprehensive for successful execution and to point away from concentrated and effective effort. But the question may be put, if planetary problems remain to be done outside of a field of narrower limits than here assumed, who will undertake that work? If our knowledge of the planets is incomplete, or even wholly lacking, in many places, and if there are possibilities in the way of supplementing partial data or of gathering new information, it would seem to be the duty of our committee to recommend and to encourage new researches among the planetary observers, and, wherever necessary, to enlist the assistance and coöperation of specialists in other sections and allied sciences in the solution of outstanding and new problems.

No specific provision has apparently been made for the observations of the satellites. Some of the work connected with them is evidently nearer to the planetary observers than any of the other committees. Micrometric observations for position may be assigned in part to double star observers and observers not directly occupied with observations of planetary surface markings, but certain classes of work on the satellites naturally belong to the planetary observers, and should and will probably be carried out only by them. We would therefore suggest that the satellites be included with planetary research.

It has been suggested that observations of the minor planets should form a part of the work of the section on physical observation of the planets, and include observations on the variability of their light, etc. This work seems to us to fall naturally in the fields of asteroid and variable star observers because they are equipped for such work and it therefore will fit into their programs, whereas the planetary observers would generally find such work unsuited to their equipment and their usual programs. But the assistance of the planetary observers could be enlisted as far as their own programs of research will permit.

In physical observations of the planets we would recommend the continuation of systematic visual observations along well-established lines followed in the past. A number of suggestions have been offered that should be of some value, in the light of our own experience in planetary work. Visual observations have been carried on so long and so much has been written and published on the subject, that we have considered it to be more profitable to give at this time some attention to the photographic method of observing planets. Other promising lines of research are also included in the outline which follows.

## OUTLINE

### Field of Work: The Planets and Their Satellites: Classes of Investigation and Methods of Observation.

*Visual and photographic observations.* The greatest care should be exercised in the accumulation of accurate drawings of surface mark-

ings, for position, structure, form, and intensity. The drawings and observational notes should be supplemented by photographs whenever possible. Extended and systematic observations will provide material for the study of changes and their interpretation. It is desirable that the material be as homogeneous as possible over long periods for the detection of variations or changes which take place slowly.

*Visual and photographic photometry of planetary surfaces:* (a) to measure the relative brightness of different parts of the surfaces; (b) to determine the character of the variations of the brightness of the markings; (c) to work for the detection of rotation in cases where this element is uncertain or unknown; (d) to acquire more definite information on planetary atmospheres from the study of transitory obscurations and other ephemeral phenomena.

*Spectrographic observations:* (a) on the constitution of planetary atmospheres; (b) of different regions as bearing on the nature of the detail as well as more extended areas; and the surface in general; (c) for tests on the question of rotation and possibly on atmospheric circulation in the case of Jupiter.

*Radiometric measures:* (See end of report.)

*Color filter observations by direct photographs:* with color sensitive emulsions and reflecting telescopes, calibrated by spectrographic observations. This method should supplement and in some cases replace the more laborious spectrographic observations and give valuable information on the nature of the detail studied and the changes taking place.

*Colorimetry.* Color observations of planetary markings are difficult. The personal equation in the perception and judgment of colors introduces much uncertainty, even under favorable conditions, and in planetary work the matter is further complicated by the faintness of the colors and instrumental effects, as in the case of a refractor and a reflector. Perhaps three-color photographs with reflecting telescopes may be used to advantage until more trustworthy visual methods are developed.

*Polarimetry.* For certain planetary observations polarization tests should be useful. Refined observations are needed.

*Occultations of stars by the planets.* Observations of the occultation of a star of suitable brightness by any of the planets will be specially valuable, as it will give some idea of their atmospheres, and in the case of Saturn will be important in connection with the nature of the density and composition of the rings.

*Satellite Observations:* (a) visual observations of surface markings and form of disk; (b) photometric observations of brightness, and examination of the light for variability, as bearing on form, dimensions, and rotation; (c) micrometric and interference measures of dimensions; (d) micrometric and photographic observations for posi-

tion; (e) transits and eclipses; (f) spectrographic observations of the brighter ones; (g) search for new satellites.

### Visual Observations

It is not intended by what is said here to restrict the field of investigation or to direct the observer along particular lines of research, as it seems better that the observer follow whatever investigations he believes can be most advantageously carried out by him, but because of the need of improving methods of observing planetary surfaces and increasing the accuracy, comparableness, and value of the results, the following suggestions are offered.

*Reports.* It is desirable that reports of observations contain a definite statement of the instrumental equipment with which, and the conditions of seeing under which, they are made.

*Scale of Seeing.* The adoption of a scale for rating the seeing based on the diffraction pattern of the star disk, graduated from 1 to 10, the latter denoting perfect definition. Regard for these two suggestions would greatly aid in comparing and evaluating observations, and in interpreting results.

*Blank forms for drawings.* For better drawings it is suggested that the observer be provided with blank forms preferably of standard size (40 millimeters in diameter have been found a very satisfactory size) on good plate paper, upon which to make drawings of Mars, Jupiter, and Saturn. Those of Jupiter and Saturn should not be circles but ellipses of correct form for the apparent oblateness of the planet at the time of observation. Besides standardizing the results, this would eliminate errors due to haphazard attempts to shape the drawing, and, by greatly facilitating the work thereby, all of the observer's attention can be directed to the other essentials of the observations. For those observers who cannot meet these provisions a simpler method is to have proper elliptical discs cut from stiff cardboard. With these it will be possible to trace the outlines of Saturn and Jupiter. However, in the case of Mars it will be necessary, if the drawings are to be of much value, to have circles drawn with proper *phase* and *orientation* for the dates desired.

*Drawings should be completed at the telescope.* It is important for accuracy that all drawings and notes be completed at the telescope at the time of the observation. This will tend to prevent anything entering the observations other than as actually seen at the telescope.

*Care in drawing.* The greatest care should be exercised in making the drawings so that they represent the markings in their true relations to one another particularly as to position, form and intensity, in order for the observations to be of most value in comparison for changes, and in determining the nature and cause of the markings. Accurate timing is essential. It is very desirable that, when sketches are made,

the times should be properly noted, when the fundamental points are laid down.

*Use of the micrometer.* The use of the micrometer is urged in all kinds of visual observations, because its various applications are an important aid to the observer in determining the position, size, form, and to some extent even the reality, of markings by comparisons with the threads. Setting the thread to the position angle given by the ephemeris for the axis of rotation of the planet, to secure the proper orientation, is an important aid to accuracy. For those who are not fortunate enough to have a micrometer many simple devices for orienation will doubtless suggest themselves as, for example, a fixed thread in the focus of the eye-piece, with a properly graduated circle (even an ordinary paper protractor will do) attached externally to the eyepiece, will enable one to get the equator by trail and then to properly set the thread in the position given by the ephemeris for the planet's axis. Taking the position angles of markings will increase the accuracy of the drawing.

*Experiments.* Control experiments are recommended wherein quantitative determinations will serve as a check for the observer and tend to increase accuracy. It is suggested that experiments be made by observing artificial planets, test drawings, or the actual drawings made at the telescope, under like conditions of seeing and with the same instrumental equipment as used in the regular observations, because these prove to be excellent guides for the observer in arriving at the limitations of the observations, and in showing whether the drawings truly represent the planet. In addition to these, various laboratory experiments may also be profitably carried out.

*Diaphragming the objective and eye-piece.* It is recommended that with large apertures an iris diaphragm be used over the objective, allowing adjustment from the eye-end for varying the aperture according to the seeing. This improves the definition on poor nights and thereby permits useful work to be done, and thus preserves the continuity of the observations. A number of small caps to fit over the eye-piece, each with a small hole in it for cutting down the beam of light before it enters the eye, is useful where no iris diaphragm is available, and in certain measurements serviceable in avoiding parallax of threads by keeping the eye in the optical axis.

*Use of neutral and tinted glass shades.* The use of tinted glass shades over the eyepiece, arranged to permit different tints and densities to be employed, will often greatly improve the observing on the brighter planets, by suitably reducing the light and enhancing the contrast of markings, especially in large telescopes. The efficacy of this method is shown by the manner in which it reduces the size of the spurious disk of a bright star, and thus should improve the definition on bright planetary surfaces.

*Longitudes, latitudes, and related observations.* In determining longitudes of markings for periodic times, and for locating fundamental points in map making and drawing, either micrometric measures, or eye estimates aided by the micrometer threads, of the transits of the markings across the central meridian may be used. Probably the latter method is the better, but if used it is important that the observations be made at or near opposition time, in order to eliminate the effects of phase for which trustworthy corrections are difficult. In case of determinations for position of markings at other times it is perhaps best to make micrometric measures direct to the limb of the planet—not the terminator—so as to avoid the corrections for phase. In latitude determinations, in the case of Mars particularly, greater accuracy will be attained if the measures of markings in the polar zones are made when the poles of the planet in turn are favorably presented to the earth, in order to lessen the inaccuracies due to foreshortening.

Drawings will probably provide positions suitable for constructing maps but, because they are subject to large accidental errors, and perhaps in most cases to large systematic error due to a personal equation of the observer, in always placing markings too high, too low, too far to left or right as the case may be, as absolute determinations of latitude and longitude they give results inferior to those secured by the other methods mentioned here. Ordinarily the observer's time and attention must be divided among the various essentials of a finished drawing, and in addition the large time factor involved makes it remotely possible that a degree of precision in the position of markings will be secured which is comparable with that obtained by direct methods of measurement.

Obviously good photographs of a planet provide data for accurate and reliable determinations of latitude and longitude.

*Visual determination of transits.* Some observers find that visual observations of the transit of a marking on a planet can best be determined with the aid of two micrometer wires set perpendicular to the belts and separated by one half the diameter of the planet. If the wires are shifted so that each alternately becomes the central wire and the other one tangent to one limb or the other, the time of transit may be observed quite accurately by noting the times of certainties or uncertainties of the moment of transit. The method is shown below:

| | |
|---|---|
| Not yet | Time |
| Not yet | " |
| Transit | " |
| Transit | " |
| Perhaps past | " |
| Perhaps past | " |
| Certainly past | " |
| Transit = | Mean of times |

There will be an uncertainty of perhaps a few minutes for each esti-

mate, but the mean of the times of these uncertainties will give the transit closely to about one minute of time, in the case of Jupiter. The shifting of the wires is to avoid uncertainties of the bisection of the limb. The observer without a micrometer may use a very fine wire in the focus of his eye-piece, and by placing this wire as nearly as possible on the apparent meridian of the planet can, with a few estimates as above, determine the transit quite closely. There will probably be a personal equation in this last method but, so far as his own observations are concerned, it will not affect the resulting period. However, the observer can determine the correction for his personal equation by other means and thereby secure absolute determinations by this method.

## Planetary Photography

The photography of planetary surface detail is a subject that cannot be satisfactorily treated in a short space. The task of specifying details and classifying the results of experience in this work, for the use of others, is fraught with difficulties, due to the differences of instrumental equipment and the wide variations in the conditions under which different observers must work. A brief outline is here given in the hope that it may be of value to observers who are taking up the work without any previous experience. The following recommendations should be received, as they are offered, merely as a rough guide in assembling an equipment and for attacking the practical problems of observational work. Written insructions cannot take the place of skill in manipulation and education of the judgment which can only be acquired by actual experience.

In most cases planetary photography will probably be taken up in connection with visual observations, and it may be assumed that visual refractors and reflecting telescopes will be used. With this in mind the following topics will be briefly discussed: the camera, the amplifying lens, the double slide plate carrier, color filter, magnification, focusing, the guiding telescope and guiding, plates, exposures, developer and development.

*Camera.* For efficient work in planetary photography the design of the camera is important. As far as is consistent with the absolutely essential requirements for stability, for avoiding flexure and vibration, the camera should be as light, compact, and convenient for manipulation as possible, and be readily interchangeable with the eye-piece section of the telescope. Well designed stops are desirable for maintaining the orientation of both the micrometer section and the camera. Convenient scales should be provided for setting the amplifying lens and the camera for different magnifications. The best photographs can only be made in the comparatively rare intervals of superlatively fine seeing, and these are the precious moments the visual observer would also like to have for critical examination of the most difficult detail. If both photograph and visual work are to be carried on together to the best

advantage it is very important that the apparatus should be so designed as to reduce to a minimum the loss of time in changing from one kind of work to the other.

*The amplifying lens.* The magnification of the image may be done with either a positive or negative lens which should be of the best quality, and it would be better if it were specially corrected to go with the particular telescope with which it is to be used. Cemented negative systems have given the best results in our work thus far.

*Color filters.* Efforts should be made to obtain the most efficient filters, and for the best definition the adjustment of the transmission and absorption of such screens, to the objective and plate used, is a matter of some importance. Various forms of color filters may be used: stained gelatine films cemented between plates of optical glass; tinted glass with optically figured surfaces; and liquid filter-cells with optically figured walls. For the ordinary form of filter it is generally safest to place it only a short distance from the focal plane to minimize possible effects from distortions caused by waviness, lack of planeness, etc. Tinted glass filters of homogeneous material having optically figured plane parallel surfaces may be placed farther from the sensitive plate, and thus any small bubbles in the glass or dust specks on its surface will not show as defects in the images, and good results are obtained by placing the filter immediately in front of the amplifying lens, thus avoiding any markings due to dust shadows. Filters and color sensitive plates should also be used with reflecting telescopes for at least a part of the exposures, as it is desirable to have photo-visual values of the intensities of the planetary markings for comparisons with visual observations.

*Plate carrier.* It is advantageous to construct the plate carriage for rectangular motions (double slide), so that many exposures may be made on the same plate, with the image always held on the optical axis. It is a good practice to make many images on the same plate in order to catch the planet during some of the moments of finest definition, and to furnish checks on faint and difficult detail, photographic defects, etc.

*Shutter.* A dependable and easily operated shutter is conducive to good work. It should be a type that works without jar or vibration. A properly selected commercial shutter will meet these requirements.

*Guiding telescope and guiding.* To obtain the finest results in planetary photography careful "following" is necessary. Where such great focal lengths are used small irregularities in the driving and displacements of the image due to seeing are harmful and must be corrected as far as possible. The guiding telescope also enables the observer to select the moments of finest seeing for the exposure. It would be helpful to have a large aperture for this purpose but most observers will probably find it necessary to make use of comparatively small telescopes. It is recommended that a high magnification be used for guid-

ing, as the movements of the image, and blurring due to seeing, are more easily detected, enabling the observer better to introduce corrections in the following and to select the best moments for exposures. A very useful means to increase the magnification without employing extremely short focus eye-pieces with small telescopes, is the use of a short focus negative lens placed between the ocular and objective a short distance within the focal plane. By this method the guiding threads are sharper, not being magnified as much as the image, and there is the increased comfort of using a long focus eye-piece.

*Focus.* The focusing of the camera should be carefully done, preferably by star trails. The knife-edge method, much used for reflectors, may also be employed. It may sometimes be necessary to focus the image directly with an eye-piece but the accurate adjustment of the camera is of so great importance that it is advisable to test the settings by the more precise methods previously mentioned. It will be well to test the focus of the camera at suitable intervals to correct for any changes that may occur from temperature effects or accidental causes. Such changes sometimes occur so as to impair the definition but escape perception, or if perceived are easily attributable to seeing, therefore the true cause of poor definition is best revealed by accurate refocusing. Fine focusing can only be done on the best nights.

*Magnification.* It is a difficult matter to give definite information or rules as to the best magnification to use. In many cases an average power may be the most effective, because it is not always possible to give the necessary time to resetting the camera for changed conditions of seeing. The common error in this work has been over-magnification. A ratio of aperture to focal length of 1:70 to 1:90 may perhaps be recommended for moderately large apertures, under good observing conditions.

*Plates.* Any statements at present regarding photographic plates or films can only be provisional. Developments in the way of improved sensitive emulsion are steadily in progress, and the observer should be on the alert to test new products. Up to the present time the Cramer Isochromatic plates have in actual practice given the best results in planetary photography with visual refractors and color screens. For the observers who find it more convenient to use European plates it may be stated that the Gem Salon Iso and the Imperial Special Sensitive Orthochromatic (both English plates) have been found to give good results; the latter has the greater speed but the former probably has finer grain and perhaps a little finer resolution.[1] For reflecting telescopes working without filters so many good brands, by makers in America and Europe, are available that the observer will probably have no difficulty in selecting good emulsions. Observers

[1] Since this was written the Research Department of the Eastman Kodak Co. has produced a plate which gives fairly good results.

with reflecting telescopes should also make exposures on red sensitive plates, with suitable filters.

*Exposure.* The proper exposure of the negatives is a vital matter. Unfortunately it is not possible to give explicit instructions regarding this. But the observer willing to do experimental work at the telescope and in the laboratory, or simple experiments with small telescopes and cameras on test objects, may develop his own skill and judgment in regard to the best exposure time for the particular result sought. The observer will of course realize the important relationship between exposure and development. The time of exposure should always be accurately recorded, and the value of the photographs will be greatly enhanced if a trail is taken on each plate to give the equator, so that determinations for position of markings can be readily made. The Lowell Observatory photographs have proved of much value in position determinations, especially of latitude and longitude of markings, and it seems worth while to stress the value of taking a *trail* on each negative, and of accurate *timing*.

*Developers and development.* The development of planetary photographs is so important that the observer should give this matter the attention it deserves. Laboratory work may be done with profit. A number of good developers are available. We strongly recommend time and temperature methods of development, as it is advisable to develop color sensitive plates in complete darkness. Test photographs will determine the best exposure times and the most suitable contrast factor of development.

*General Remarks.* In initiating planetary photography with a refracting telescope without extensive preliminary tests, the observer will probably find that, with a good commercial filter which cuts all light of shorter wave-length than 4700 or 5000 used with the equipment and plates and in the manner outlined above, some success will be met with at the start. It has been determined by tests in other kinds of direct astronomical photography that photographs made from yellow light show distinctly finer definition than if made from the blue part of the spectrum. This seems equally true in photography of planetary surfaces and is probably chiefly due to the fact that the longer wave-lengths are less disturbed in passing through our atmosphere. Fortunately the reflected light from some of the planets is relatively strong in the longer wave-lengths, and the color and character of most of the planetary markings is such as to register with enhanced contrast in this light.

Doubtless it will occur to the observer to color sensitize emulsions, himself, by the use of the various dyes available for this purpose. While this seems a promising field for future development, yet as a practical means of securing better results it does not, at present, show distinct advantages over the results obtained in this class of photography with

the best commercial plates. The research laboratories of the various plate manufacturers have evidently investigated these dyes and one can obtain from them suitable plates made under conditions of control that tend to a degree of uniformity and quality generally not regularly obtainable by the busy observer. It is obvious, however, that this is a fruitful field for investigational work.

Regarding magnification it seems that two fallacies exist, one that the larger the original photographic image of a planet the better; the other, the contrary, that very small images should be made with the idea of subsequently greatly enlarging them. The first fails because the delicate details are lost through the relatively longer exposure required and the magnified disturbance in the image, and the second because of the low resolution of fast plates and the deleterious effect of the grain when the plate is much enlarged. The magnification of the image suggested in the main outline above will serve as a guide to the beginner and it should be adapted to conditions as experiment and experience suggest.

The treatment of the plate after exposure at the telescope, in development especially and in copying, is of major importance. Very contrasty, dense, or extremely large images of Jupiter or Mars may show sharp belts in the one case or sharp shore lines to the major markings in the other but experiment shows that they reveal little of the fine detail on either and, being wrong in theory, should be guarded against.

In the case of planetary photography where many images of short exposures are made, the use of film and the mechanism of a cinema camera will no doubt occur to some who are interested in the work. Such a method is of course convenient. However, with the present speed of photographic emulsions extremely short exposures with telescopes of moderate aperture are not possible without greatly reducing the size of the image to gain the necessary intensity. Thus far films have not proved to be as good for registering the small and delicate planetary detail as the best emulsions on glass, and among other things the celluloid support generally has many more small defects, usually not noticeable in ordinary views, than glass. Automatic multiplying cameras using glass plates may be readily constructed. But the observer taking up the work will no doubt find it profitable to begin with apparatus embodying the essentials for making first class photographs, elaborating his equipment as experience suggests.

Attention has been called to the critical conditions necessary in this class of planetary photography to secure the best definition of the delicate detail. In addition to the information the photographs give on the position and structure of planetary detail, they are also of great value as a photometric record of the brightness of different parts of planetary surfaces, not obtainable with the same fidelity in visual observations. As a record of the intensity of markings it is therefore advisable to make photographs to supplement the visual observations

even if conditions are not such as to obtain the finest definition. Any means for placing the equator on the plate for position measures or for standardizing the plate for photometric measures, thus making them available for accurate measurement, is very desirable. Much remains to be done in the field of planetary photography in the way of experimental work.

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[*Radiometric Measures.* At the time of the preparation of the outline on planetary observations, a program for radiometric observations of the planets had been planned in coöperation with Dr. W. W. Coblentz of the National Bureau of Standards. The importance of such measurements as a part of planetary research must be sufficiently obvious not to require any special emphasis here. Results obtained by this method bring within our reach direct evidence on planetary conditions thus far not obtainable by other means. It is to be expected that improved instrumental equipment and observational methods will be improved and developed as the work progresses. A beginning in this work was made at the Lowell Observatory in the summer of 1922 and it is hoped that it will be possible to carry on the observations systematically in the future.]

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The many outstanding planetary problems indicate the opportunities still open for gathering improved data and also for the development of new lines of investigation. More extensive and more accurate data, and work in neglected or new fields may be expected to throw light on many questions, by wholly independent or original information brought out, and also by supplementing in essential ways other observational data awaiting more satisfactory interpretations.

While the work that promises most immediate results appears to be continued accurate observations of Mars and Jupiter—as for example, the variations in the markings of the latter, measures of the size and position of the polar caps of Mars, and the close observation of the seasonal changes in these and the dark markings—yet it is hoped that the individual initiative of the observer may lead him to add new and fruitful fields to his program of investigations on planetary systems.

Respectfully submitted,

E. E. Barnard, *Chairman.*
C. O. Lampland
E. C. Slipher

PLATE XV.

Moonlit Picture. Exposure 30 Seconds.
April 20, 11:45 P. M. Pacific Time.
Moon near Perigee 42 hours after full. Altitude 33° ±.

Starlit Picture. Exposure 3 Hours 20 Minutes.
April 30, 9:50 to 13:10 Pacific Time.
Mid-Exposure at 14 hours Sidereal. Milky Way about 30° n. p.

## COMPARATIVE INTENSITY OF MOONLIGHT AND STARLIGHT.

By JAMES WORTHINGTON.

A camera of my own devising has given me the accompanying photographs, which afford an interesting comparison of the intensities of moonlight and starlight.

The Carmel Mission here shown (Plate XV) faces E. N. E.

The photographic effect obtained in both cases is about the same—on the wall of the building. So assuming that the intensity of the light was inversely proportional to the exposure time, it seems that the starlight from the quarter sphere which lit the wall was four hundred times fainter than the moonlight. This agrees well with Spencer-Jones General Astronomy, page 297, where he says that the full moon gives a hundred times as much light as all the stars together.

The camera used has an aperture of six inches, and a focal length of six inches, working at F. 1.

Carmel, Calif., May 7, 1924.

## SPEEDING.

[From a small book entitled "Between Two Eternities," "Science Songs and Whimsical Rimes." by Leland S. Copeland. Rose Garland Press, Santa Barbara, California. Reprinted with the author's permission.]

We are dashing along in our snug, wee car,
Of granite and iron and gold,
At eighteen miles a second
Through autumn, summer, and cold.
Five hundred eighty million miles
Each year we dart around
An unmarked track, as in gilt and black
Earth wheels without a sound.

Our automobile is part of a train
That moves at the slower pace
Of a dozen miles a second
In an interstellar race.
A huge and splendid machine is guide;
It lights the burnished band,
Saturn and Mars and six other cars,
To the sweeps of Lyra-land.

## PLANET NOTES FOR JULY AND AUGUST.

The *Sun* will move southward from +23° 07′ to +8° 39′, and eastward from $6^h\ 41^m$ to $10^h\ 38^m$ during this period. At the beginning of the period its motion southward will be less than 5′ a day, but at the end it will be moving southward at the rate of 22′ a day. Its path will be from Gemini through Cancer into Leo. At the end of the period the sun will be a short distance southeast of Regulus, which will, of course, be invisible because of the nearness of the sun.

The phases of the *Moon* will occur as follows:

| | | | | |
|---|---|---|---|---|
| New Moon | July | 1 at | 12 P. M. | C.S.T. |
| First Quarter | | 9 " | 4 P. M. | " |
| Full Moon | | 16 " | 6 A. M. | " |
| Last Quarter | | 23 " | 11 A. M. | " |
| New Moon | | 31 " | 2 P. M. | " |
| First Quarter | August | 7 at | 10 P. M. | C.S.T. |
| Full Moon | | 14 " | 2 P. M. | " |
| Last Quarter | | 22 " | 3 A. M. | " |
| New Moon | | 30 " | 3 A. M. | " |

The *Moon* will be nearest the earth on July 14 and on August 11, and farthest from the earth on July 16 and on August 23.

*Mercury* will be at superior conjunction with the sun on July 5. It will be moving eastward and will reach a point of greatest elongation east on August 14. On and near this date it will set about an hour and a half after the sun. It will therefore be easily visible in the western sky just after sunset. It will be in a region in which there are no bright stars, so it will not be confused with any of the fixed stars. Mercury will be occulted by the moon on August 2. The reader is referred to the paper by Professor Rigge on page 286 of the May number for detailed information concerning this phenomenon.

*Venus* will be between the earth and the sun on July 1. Toward the end of July and through the month of August it will be visible in the morning sky. On August 6 it will attain its greatest brilliancy. At this time it will be nearly three hours west of the sun, and about one hour west of Procyon.

*Earth* will be farthest from the sun for the year on July 3.

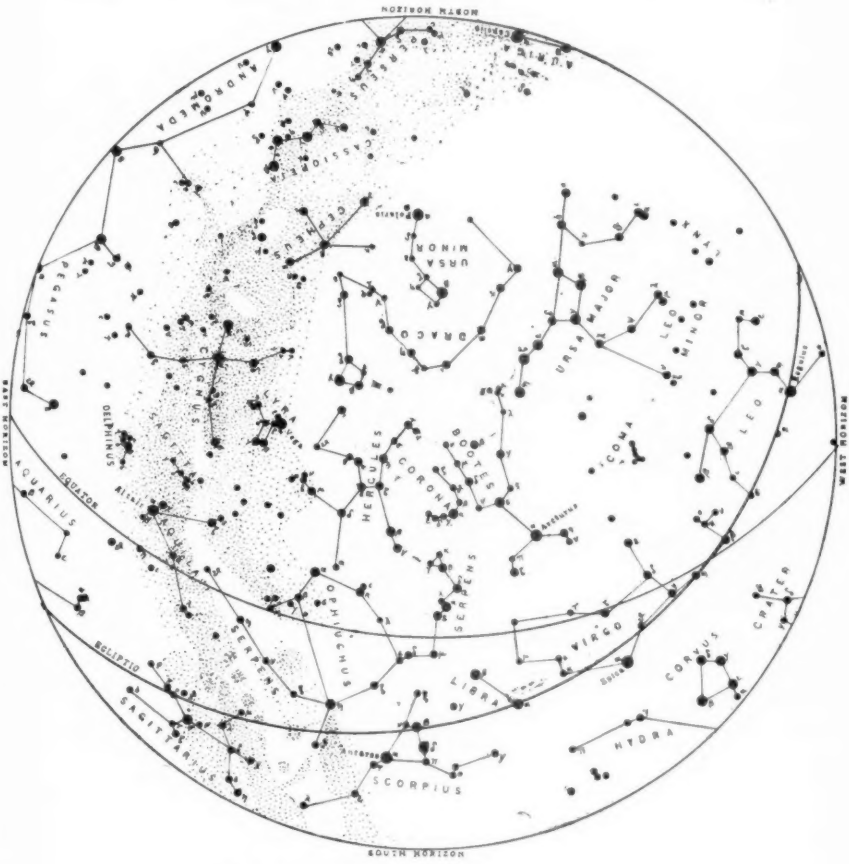
*Mars* will be of more than ordinary interest during these months. At the beginning of July it will be in a position for observation only after midnight. It will, however, rise earlier day after day, and move nearer to the earth day after day until August 22, when it will be at its nearest point. At this time it will be less than 35,000,000 miles away and will be on the meridian at midnight. The one unfavorable feature for northern observers is that the planet will be 17° south of the equator.

*Jupiter* will be in favorable position during these two months. On July 1 it will cross the meridian at 10 o'clock in the evening and on August 31 it will cross the meridian at 6 o'clock. It will still be about 21° south of the equator.

*Saturn* will be well located for observation during the greater part of this period. It will be in quadrature with the sun, 90° east, on July 18. By the end of August it will cross the meridian in the middle of the afternoon, and consequently will be visible only in the early evening. It also is south of the equator.

*Uranus* will be visible in the morning during July and late in the evening during August.

*Neptune* will be in conjunction with the sun on August 12. It will consequently be too near the sun to be seen during this period.




THE CONSTELLATIONS AT 9:00 P. M. JULY 1.

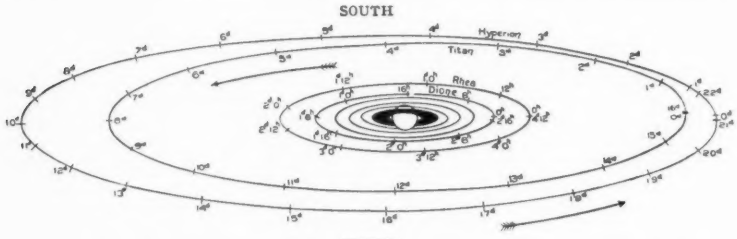
## Saturn's Satellites.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, NOON = $0^h$

I. Mimas. Perod $0^d$ $22^h.6$.

| 1924 | d | h | | d | h | | d | h | | d | h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 1 | 12.0 E | July | 9 | 12.3 W | July | 17 | 12.6 E | July | 26 | 11.6 W |
| | 2 | 10.7 E | | 10 | 11.0 W | | 18 | 11.3 E | | 27 | 10.2 W |
| | 3 | 9.3 E | | 11 | 9.6 W | | 19 | 9.9 E | | 28 | 8.8 W |
| | 4 | 7.9 E | | 12 | 8.2 W | | 20 | 8.5 E | | 29 | 7.4 W |
| | 8 | 13.7 W | | 13 | 6.8 W | | 21 | 7.1 E | | | |
| Aug. | 3 | 11.9 E | Aug. | 6 | 7.7 E | Aug. | 14 | 8.0 W | Aug. | 22 | 8.3 E |
| | 4 | 10.5 E | | 12 | 10.8 W | | 15 | 6.7 W | | 23 | 7.0 E |
| | 5 | 9.1 E | | 13 | 9.4 W | | 21 | 9.7 E | | | |




Apparent orbits of the seven inner satellites of Saturn at date of opposition, April 18, 1924, as seen in an inverting telescope.

II. Enceladus. Period 1$^d$ 8$^h$.9.

| 1924 | d | h | | d | h | | d | h | | d | h | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 2 | 2.3 | E | July 10 | 7.6 | E | July 18 | 13.0 | E | July 25 | 9.4 | E |
| | 3 | 11.2 | E | 11 | 16.5 | E | 19 | 21.9 | E | 26 | 18.3 | E |
| | 4 | 20.1 | E | 13 | 1.4 | E | 21 | 6.8 | E | 28 | 3.2 | E |
| | 6 | 5.0 | E | 14 | 10.3 | E | 22 | 15.7 | E | 29 | 12.1 | E |
| | 7 | 13.9 | E | 15 | 19.2 | E | 24 | 0.6 | E | 30 | 21.0 | E |
| | 8 | 22.7 | E | 17 | 4.1 | E | | | | | | |
| Aug. | 1 | 5.9 | E | Aug. 8 | 2.4 | E | Aug. 14 | 22.9 | E | Aug. 20 | 10.5 | E |
| | 2 | 14.8 | E | 9 | 11.3 | E | 16 | 7.8 | E | 21 | 19.4 | E |
| | 3 | 23.7 | E | 10 | 20.2 | E | 17 | 16.7 | E | 23 | 4.3 | E |
| | 5 | 8.6 | E | 12 | 5.1 | E | 19 | 1.6 | E | 24 | 13.2 | E |
| | 6 | 17.5 | E | 13 | 14.0 | E | | | | | | |

III. Tethys. Period 1$^d$ 21$^h$.3.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 2 | 13.4 | E | July 10 | 2.7 | E | July 17 | 15.9 | E | July 25 | 5.2 | E |
| | 4 | 10.7 | E | 12 | 0.0 | E | 19 | 13.2 | E | 27 | 2.5 | E |
| | 6 | 8.0 | E | 13 | 21.3 | E | 21 | 10.6 | E | 28 | 23.9 | E |
| | 8 | 5.3 | E | 15 | 18.6 | E | 23 | 7.9 | E | 30 | 21.2 | E |
| Aug. | 1 | 18.5 | E | Aug. 7 | 10.5 | E | Aug. 13 | 2.4 | E | Aug. 18 | 18 4 | E |
| | 3 | 15.8 | E | 9 | 7.8 | E | 14 | 23.8 | E | 20 | 15.7 | E |
| | 5 | 13.2 | E | 11 | 5.1 | E | 16 | 21.1 | E | 22 | 13.1 | E |
| | | | | | | | | | | 24 | 10.4 | E |

IV. Dione. Period 2$^d$ 17$^h$.7.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 3 | 7.0 | E | July 11 | 12.0 | E | July 19 | 17.1 | E | July 27 | 22.3 | E |
| | 6 | 0.7 | E | 14 | 5.7 | E | 22 | 10.8 | E | 30 | 16.0 | E |
| | 8 | 18.3 | E | 16 | 23.4 | E | 25 | 4.5 | E | | | |
| Aug. | 2 | 9.7 | E | Aug. 7 | 21.1 | E | Aug. 13 | 8.6 | E | Aug. 18 | 20.0 | E |
| | 5 | 3.4 | E | 10 | 14.9 | E | 16 | 2.3 | E | 21 | 13.7 | E |
| | | | | | | | | | | 24 | 7.4 | E |

V. Rhea. Period 4$^d$ 12$^h$.5.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 4 | 9.2 | E | July 13 | 10.1 | E | July 22 | 11.0 | E | July 31 | 12.0 | E |
| | 8 | 21.6 | E | 17 | 22.6 | E | 26 | 23.5 | E | | | |
| Aug. | 5 | 0.5 | E | Aug. 9 | 13.0 | E | Aug. 14 | 1.5 | E | Aug. 18 | 14.0 | E |
| | | | | | | | | | | 23 | 2.6 | E |

VI. Titan. Period 15$^d$ 23$^h$.3.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 7 | 2.9 | W | July 15 | 2.4 | E | July 23 | 2.0 | W | July 31 | 1.8 | E |
| Aug. | 8 | 1.6 | W | Aug. 16 | 1.5 | E | Aug. 24 | 1.6 | W | | | |

VII. Hyperion. Period 21$^d$ 7$^h$.6

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July | 5 | 12.9 | W | July 17 | 1.0 | E | July 26 | 20.9 | W | | | |
| Aug. | 7 | 8.9 | E | Aug. 17 | 6.3 | W | | | | | | |

NOTE—E, Eastern Elongation; W, Western Elongation.

## Occultations Visible at Washington.

[*From the American Ephemeris*]

| Date 1924 | Star's Name | Magnitude | IMMERSION. Washington M.T. | IMMERSION. Angle from N | EMERSION. Washington M.T. | EMERSION. Angle from N | Duration |
|---|---|---|---|---|---|---|---|
| | | | h m | ° | h m | ° | h m |
| July 9 | 65 Virginis | 6.0 | 9 21 | 103 | 10 28 | 301 | 1 7 |
| 9 | 66 Virginis | 5.7 | 10 9 | 126 | 11 12 | 275 | 1 2 |
| 14 | 16 Sagittarii | 5.9 | 7 40 | 158 | 8 16 | 220 | 0 36 |
| 16 | $\pi$ Capricorni | 5.2 | 10 6 | 78 | 11 22 | 267 | 1 16 |
| 18 | 58 Aquarii | 6.4 | 15 32 | 34 | 16 40 | 275 | 1 8 |
| 19 | $\chi$ Aquarii | 5.3 | 10 18 | 68 | 11 23 | 257 | 1 5 |
| 24 | B. Tauri | 6.2 | 14 31 | 58 | 50 40 | 258 | 1 9 |
| 25 | 179 B. Tauri | 5.9 | 12 48 | 8 | 13 9 | 321 | 0 21 |
| 26 | 318 B. Tauri | 5.7 | 13 4 | 49 | 30 51 | 285 | 0 47 |
| Aug. 2 | Mercury | 0.2 | 5 19 | 182 | 5 48 | 224 | 0 28 |
| 7 | 13 Librae | 5.7 | 7 33 | 72 | 8 33 | 327 | 1 0 |
| 18 | 117 G. Piscium | 6.5 | 10 59 | 65 | 12 8 | 247 | 1 9 |

## Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, NOON = $0^h$

| 1924 | h m | | | 1924 | h m | | |
|---|---|---|---|---|---|---|---|
| July 1 | 8 34 | III | Sh. E. | July 11 | 9 58 | I | Sh. E. |
| | 10 21 | II | Tr. I. | 12 | 7 14.0 | I | Ec. R. |
| | 11 31 | II | Sh. I. | 15 | 10 34 | III | Tr. I. |
| | 12 42 | II | Tr. E. | 17 | 9 23 | II | Oc. D. |
| 2 | 10 45 | I | Tr. I. | | 11 34 | I | Oc. D. |
| | 11 22 | I | Sh. I. | 18 | 8 46 | I | Tr. I. |
| | 12 56 | I | Tr. E. | | 9 41 | I | Sh. I. |
| 3 | 8 1 | I | Oc. D. | | 10 57 | I | Tr. E. |
| | 8 25.9 | II | Ec. R. | | 11 53 | I | Sh. E. |
| | 10 51.0 | I | Ec. R. | 19 | 8 22 | II | Sh. E. |
| 4 | 7 23 | I | Tr. E. | | 9 8.6 | I | Ec. R. |
| | 8 3 | I | Sh. E. | 24 | 11 47 | II | Oc. D. |
| 8 | 7 7 | III | Tr. I. | 25 | 10 35 | I | Tr. I. |
| | 9 26 | III | Tr. E. | | 11 36 | I | Sh. I. |
| | 10 3 | III | Sh. I. | 26 | 7 49 | I | Oc. D. |
| | 12 33 | III | Sh. E. | | 8 10.0 | III | Ec. D. |
| | 12 38 | II | Tr. I. | | 8 32 | II | Sh. I. |
| 9 | 12 31 | I | Tr. I. | | 8 53 | II | Tr. E. |
| 10 | 9 47 | I | Oc. D. | | 10 43.8 | III | Ec. R. |
| | 11 3.5 | II | Ec. R. | | 10 57 | II | Sh. E. |
| | 12 45.4 | I | Ec. R. | | 11 3.2 | I | Ec. R. |
| 11 | 7 46 | I | Sh. I. | 27 | 7 13 | I | Tr. E. |
| | 9 9 | I | Tr. E. | | 8 17 | I | Sh. E. |
| Aug. 2 | 7 38 | III | Oc. D. | Aug. 11 | 8 25.7 | II | Ec. D. |
| | 8 55 | II | Tr. I. | | 9 21.3 | I | Ec. R. |
| | 9 39 | I | Oc. D. | 13 | 8 35 | III | Sh. E. |
| | 10 4 | III | Oc. R. | 18 | 7 49 | I | Oc. D. |
| | 11 7 | II | Sh. I. | | 8 29 | II | Oc. D. |
| 3 | 6 53 | I | Tr. I. | 19 | 7 16 | I | Tr. E. |
| | 8 0 | I | Sh. I. | | 8 32 | I | Sh. E. |
| | 9 4 | I | Tr. E. | 20 | 7 25 | III | Tr. E. |
| | 10 12 | I | Sh. E. | | 7 59 | II | Sh. E. |
| 4 | 7 26.5 | I | Ec. R. | | 10 0 | III | Sh. I. |
| | 8 15.8 | II | Ec. R. | 26 | 6 59 | I | Tr. I. |
| 10 | 8 44 | I | Tr. I. | | 8 16 | I | Sh. I. |
| | 9 56 | I | Sh. I. | | 9 10 | I | Tr. E. |
| 11 | 8 24 | II | Oc. R. | 27 | 7 39.7 | I | Ec. R. |

| 1924 | d | h | | d | h | 1924 | d | h | | d | h |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug. 27 | 8 | 2 | II | | Tr. E. | Aug. 27 | 8 | 50 | III | | Tr. I. |
| | 8 | 8 | II | | Sh. I. | 31 | 6 | 44.5 | III | | Ec. R. |

NOTE:—I, denotes ingress; E, egress; D, disappearance; R, reappearance; Ec, eclipse; Oc, occultation; Tr, Transit of the satellite; Sh, transit of the shadow.

## VARIABLE STARS.

### Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

| Star | R.A. 1900 | | Decl. 1900 | | Magnitude | Approx. Period | | Greenwich mean times of minima in 1924 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | July | | | | August | |
| | h | m | ° | ′ | | d | h | d | h | d | h | d | h |
| SY Androm. | 0 | 08.0 | +43 | 09 | 9.5—13.0 | 34 | 21.8 | 8 | 6 | | | 12 | 4 |
| RT Sculptor. | | 31.5 | —26 | 13 | 9.6—10.5 | 0 | 12.3 | 13 | 15 | 29 | 0 | 13 | 8 | 28 | 16 |
| U Cephei | 0 | 52.4 | +81 | 20 | 7.0— 9.0 | 1 | 11.8 | 7 | 10 | 22 | 9 | 13 | 20 | 28 | 19 |
| Z Persei | 2 | 33.7 | +41 | 46 | 9.4—12 | 3 | 01.4 | 7 | 18 | 26 | 2 | 7 | 9 | 19 | 13 |
| TW Cassiop. | | 37.6 | +65 | 19 | 8.2— 9.0 | 1 | 10.3 | 8 | 19 | 25 | 23 | 12 | 2 | 29 | 5 |
| RY Persei | | 39.0 | +47 | 43 | 8.0—10.3 | 6 | 20.7 | 6 | 4 | 19 | 21 | 2 | 15 | 23 | 5 |
| RZ Cassiop. | | 39.9 | +69 | 13 | 6.9— 8.1 | 1 | 04.7 | 10 | 3 | 24 | 11 | 7 | 19 | 22 | 3 |
| TX Cassiop. | | 44.4 | +62 | 22 | 9.4—10.1 | 2 | 22.2 | 5 | 21 | 23 | 11 | 10 | 1 | 27 | 14 |
| ST Persei | | 53.7 | +38 | 47 | 8.5—10.5 | 2 | 15.6 | 10 | 16 | 26 | 14 | 10 | 11 | 27 | 8 |
| RX Cassiop. | 2 | 58.8 | +67 | 11 | 8.6— 9.1 | 32 | 07.6 | 7 | 4 | | | 8 | 12 | | |
| Algol | 3 | 01.7 | +40 | 34 | 2.3— 3.5 | 2 | 20.8 | 9 | 1 | 26 | 5 | 12 | 10 | 29 | 15 |
| RT Persei | | 16.7 | +46 | 12 | 9.5—11.5 | 0 | 20.4 | 10 | 11 | 24 | 1 | 6 | 15 | 20 | 5 |
| λ Tauri | | 55.1 | +12 | 12 | 3.3— 4.2 | 3 | 22.9 | 6 | 12 | 22 | 7 | 7 | 3 | 22 | 22 |
| RW Tauri | 3 | 57.8 | +27 | 51 | 7.1— [11 | 2 | 18.5 | 12 | 11 | 29 | 2 | 6 | 9 | 23 | 0 |
| RV Persei | 4 | 04.2 | +33 | 59 | 9.5—11.0 | 1 | 23.4 | 6 | 18 | 22 | 13 | 7 | 8 | 23 | 3 |
| RW Persei | | 13.3 | +42 | 04 | 8.8—11.0 | 13 | 04.8 | 10 | 19 | 23 | 23 | 6 | 4 | 19 | 9 |
| SZ Tauri | | 31.4 | +18 | 20 | 7.2— 7.7 | 3 | 03.6 | 11 | 19 | 24 | 9 | 12 | 7 | 24 | 21 |
| RS Cephei | 4 | 48.6 | +80 | 06 | 9.5—12.0 | 12 | 10.1 | 4 | 17 | 29 | 13 | 10 | 23 | 23 | 9 |
| TT Aurigae | 5 | 02.8 | +39 | 27 | 7.8— 8.7 | 0 | 16.0 | 5 | 23 | 19 | 7 | 8 | 7 | 21 | 15 |
| RY Aurigae | | 11.5 | +38 | 13 | 10.7—11.7 | 2 | 17.5 | 3 | 9 | 19 | 18 | 5 | 2 | 21 | 11 |
| RZ Aurigae | | 42.9 | +31 | 40 | 10.6—13.3 | 3 | 00.3 | 7 | 6 | 19 | 7 | 6 | 9 | 24 | 10 |
| SV Tauri | | 45.8 | +28 | 05 | 9.4—11.0 | 2 | 04.0 | 12 | 6 | 29 | 14 | 7 | 6 | 24 | 14 |
| Z Orionis | | 50.2 | +13 | 40 | 9.7—10.7 | 5 | 04.9 | 6 | 0 | 26 | 19 | 6 | 5 | 27 | 1 |
| SV Gemin. | | 54.6 | +24 | 28 | 9.8— [11 | 4 | 00.2 | 7 | 11 | 23 | 12 | 8 | 12 | 24 | 13 |
| RW Gemin. | 5 | 55.4 | +23 | 08 | 9.5—11.0 | 2 | 20.8 | 9 | 9 | 20 | 20 | 7 | 1 | 24 | 5 |
| U Columbæ | 6 | 11.2 | —33 | 03 | 9.2—10.0 | 2 | 19.2 | 11 | 5 | 22 | 10 | 8 | 5 | 25 | 0 |
| SX Gemin. | | 22.0 | +20 | 37 | 10.8—11.5 | 1 | 08.8 | 15 | 6 | 31 | 16 | 8 | 21 | 25 | 6 |
| RW Monoc. | | 29.3 | + 8 | 54 | 9.0—10.8 | 1 | 21.7 | 3 | 19 | 19 | 1 | 3 | 7 | 18 | 13 |
| RX Gemin. | | 43.6 | +33 | 21 | 8.8— 9.6 | 12 | 05.0 | 9 | 16 | 21 | 21 | 3 | 2 | 27 | 12 |
| RU Monoc. | 6 | 49.4 | — 7 | 28 | 9.8—10.5 | 0 | 21.5 | 7 | 13 | 21 | 21 | 5 | 5 | 19 | 13 |
| R Can. Maj. | 7 | 14.9 | —16 | 12 | 5.8— 6.4 | 1 | 03.3 | 10 | 16 | 23 | 7 | 6 | 22 | 20 | 13 |
| RY Gemin. | | 21.7 | +15 | 52 | 8.9— [10 | 9 | 07.2 | 9 | 23 | 28 | 13 | 6 | 20 | 25 | 11 |
| Y Camelop. | | 27.6 | +76 | 17 | 9.5—12 | 3 | 07.3 | 8 | 9 | 21 | 14 | 3 | 19 | 23 | 15 |
| TX Gemin. | | 30.3 | +17 | 08 | 10.0—11.9 | 2 | 19.2 | 5 | 3 | 22 | 17 | 8 | 12 | 25 | 8 |
| RR Puppis | | 43.5 | —41 | 08 | 9.4—10.7 | 6 | 10.3 | 11 | 15 | 24 | 12 | 6 | 8 | 19 | 5 |
| V Puppis | 7 | 55.4 | —48 | 58 | 4.1— 4.8 | 1 | 10.9 | 6 | 12 | 21 | 1 | 2 | 14 | 19 | 3 |
| X Carinae | 8 | 29.1 | —58 | 53 | 7.9— 8.7 | 0 | 13.0 | 2 | 2 | 18 | 8 | 3 | 14 | 19 | 20 |
| S Cancri | 8 | 38.2 | +19 | 24 | 8.2—10 | 9 | 11.6 | 5 | 7 | 24 | 6 | 2 | 18 | 21 | 17 |
| RX Hydrae | 9 | 00.8 | — 7 | 52 | 9.1—10.5 | 2 | 06.8 | 7 | 11 | 21 | 4 | 3 | 20 | 24 | 9 |
| S Velorum | | 29.4 | —44 | 46 | 7.8— 9.3 | 5 | 22.4 | 7 | 22 | 25 | 17 | 6 | 14 | 24 | 9 |
| Y Leonis | 9 | 31.1 | +26 | 41 | 9.3—11.2 | 1 | 16.5 | 9 | 0 | 22 | 12 | 11 | 17 | 25 | 5 |
| RR Velorum | 10 | 17.8 | —41 | 36 | 10.0—10.9 | 1 | 20.5 | 2 | 19 | 17 | 15 | 8 | 21 | 23 | 17 |
| SS Carinæ | 10 | 54.2 | —61 | 23 | 12.2—12.8 | 3 | 07.2 | 9 | 23 | 23 | 4 | 12 | 0 | 25 | 5 |
| ST Urs. Maj. | 11 | 22.4 | +45 | 44 | 6.7— 7.2 | 8 | 19.2 | 8 | 10 | 26 | 0 | 3 | 19 | 21 | 10 |
| RW Urs. Maj. | | 35.4 | +52 | 34 | 10.3—11.4 | 7 | 07.9 | 3 | 17 | 18 | 9 | 9 | 9 | 24 | 1 |
| Z Draconis | 11 | 39.8 | +72 | 49 | 9.9—13.6 | 1 | 08.6 | 14 | 5 | 27 | 18 | 10 | 8 | 23 | 22 |
| RZ Centauri | 12 | 55.6 | —64 | 05 | 8.5— 8.9 | 1 | 21.0 | 8 | 18 | 23 | 18 | 15 | 7 | 30 | 7 |

**Minima of Variable Stars of Short Period**—Continued.

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of minima in 1924 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | July | | | | August | | | |
| | h m | ° ′ | | d h | d | h | d | h | d | h | d | h |
| RS Can. Ven | 13 06.3 | +36 28 | 7.5—12.5 | 4 19.1 | 5 | 19 | 25 | 0 | 3 | 14 | 22 | 19 |
| SS Centauri | 07.2 | —63 37 | 8.8—10.4 | 2 11.5 | 3 | 9 | 18 | 6 | 9 | 13 | 24 | 10 |
| SX Hydræ | 13 39.0 | —26 23 | 8.6—12.7 | 2 21.5 | 8 | 20 | 20 | 11 | 6 | 20 | 24 | 5 |
| δ Libræ | 14 55.6 | — 8 07 | 4.8— 6.2 | 2 07.9 | 2 | 11 | 23 | 10 | 6 | 9 | 20 | 8 |
| U Coronæ | 15 14.1 | +32 01 | 7.6— 8.7 | 3 10.9 | 9 | 23 | 23 | 18 | 6 | 13 | 20 | 8 |
| TW Draconis | 15 32.4 | +64 14 | 7.3— 8.9 | 2 19.4 | 2 | 10 | 19 | 6 | 5 | 2 | 21 | 22 |
| SS Libræ | 15 43.4 | —15 14 | 9.3—11.5 | 0 18.4 | 8 | 16 | 23 | 2 | 5 | 11 | 20 | 20 |
| SW Ophiuchi | 16 11.1 | — 6 44 | 9.2—10.0 | 2 10.7 | 8 | 1 | 22 | 18 | 6 | 10 | 21 | 2 |
| SX Ophiuchi | 12.6 | — 6 25 | 10.5—11.2 | 2 01.5 | 7 | 9 | 23 | 21 | 9 | 9 | 25 | 22 |
| R Aræ | 31.1 | —56 48 | 6.8— 7.9 | 4 10.2 | 5 | 20 | 23 | 13 | 10 | 6 | 27 | 23 |
| TT Herculis | 16 49.9 | +17 00 | 8.9— 9.3 | 20 18.1 | | | 18 | 7 | 8 | 1 | 28 | 19 |
| TU Herculis | 17 09.8 | +30 50 | 9.5—12 | 2 06.4 | 10 | 20 | 24 | 10 | 7 | 1 | 20 | 15 |
| U Ophiuchi | 11.5 | + 1 19 | 6.0— 6.7 | 0 20.1 | 7 | 14 | 24 | 8 | 1 | 18 | 18 | 12 |
| μ Herculis | 13.6 | +33 12 | 4.6— 5.4 | 2 01.2 | 8 | 10 | 26 | 22 | 8 | 5 | 26 | 16 |
| TX Herculis | 15.4 | +42 00 | 8.3— 9.0 | 1 00.7 | 9 | 19 | 22 | 4 | 9 | 17 | 22 | 2 |
| RV Ophiuchi | 29.8 | + 7 19 | 9. —12 | 3 16.5 | 8 | 6 | 23 | 0 | 6 | 18 | 21 | 12 |
| SZ Herculis | 36.0 | +33 01 | 9.5—10.3 | 0 19.6 | 2 | 7 | 18 | 16 | 4 | 1 | 20 | 10 |
| TX Scorpii | 48.6 | —34 13 | 7.5— 8.2 | 0 22.6 | 8 | 15 | 23 | 17 | 7 | 19 | 22 | 21 |
| UX Herculis | 49.7 | +16 57 | 8.8—10.5 | 1 13.2 | 4 | 15 | 20 | 3 | 4 | 15 | 20 | 2 |
| Z Herculis | 53.6 | +15 09 | 7.1— 7.9 | 3 23.8 | 7 | 17 | 23 | 16 | 8 | 15 | 24 | 15 |
| WX Sagittarii | 53.6 | —17 24 | 9.2—10.8 | 2 03.1 | 8 | 17 | 25 | 18 | 11 | 19 | 28 | 20 |
| WY Sagittarii | 17 54.9 | —23 01 | 9.5—10.6 | 4 16.0 | 7 | 17 | 21 | 18 | 9 | 10 | 23 | 11 |
| SX Draconis | 18 03.0 | +58 23 | 9.3—10.5 | 5 04.1 | 9 | 19 | 25 | 7 | 9 | 19 | 25 | 7 |
| RS Sagittarii | 11.0 | —34 08 | 5.9— 6.3 | 2 10.0 | 11 | 2 | 25 | 14 | 9 | 2 | 23 | 14 |
| V Serpentis | 11.1 | —15 34 | 9.5—11.1 | 3 10.9 | 8 | 11 | 22 | 7 | 5 | 2 | 18 | 22 |
| RZ Scuti | 21.1 | — 9 15 | 7.4— 8.3 | 15 03.2 | 15 | 7 | 30 | 10 | 14 | 13 | 29 | 16 |
| RZ Draconis | 21.8 | +58 50 | 9.5—10.2 | 0 13.2 | 4 | 11 | 18 | 19 | 9 | 6 | 23 | 14 |
| RX Herculis | 26.0 | +12 32 | 7.0— 7.6 | 0 21.3 | 9 | 23 | 24 | 4 | 7 | 10 | 21 | 15 |
| SX Sagittarii | 39.7 | —30 36 | 8.7— 9.8 | 2 01.8 | 4 | 12 | 21 | 2 | 6 | 17 | 23 | 8 |
| RR Draconis | 40.8 | +62 34 | 9.3—13 | 2 19.9 | 7 | 5 | 24 | 5 | 10 | 4 | 27 | 4 |
| RS Scuti | 43.7 | —10 21 | 9.3—10.3 | 0 15.9 | 7 | 16 | 20 | 23 | 3 | 5 | 23 | 4 |
| β Lyræ | 46.4 | +33 15 | 3.4— 4.1 | 12 21.8 | 13 | 16 | 26 | 14 | 8 | 11 | 21 | 9 |
| U.Scuti | 18 48.9 | —12 44 | 9.1— 9.6 | 0 22.9 | 6 | 7 | 21 | 14 | 5 | 20 | 21 | 3 |
| RX Draconis | 19 01.1 | +58 35 | 9.3—10.2 | 1 21.4 | 6 | 7 | 21 | 10 | 13 | 4 | 28 | 7 |
| RV Lyræ | 12.5 | +32 15 | 11. —12.8 | 3 14.4 | 5 | 0 | 26 | 14 | 10 | 0 | 24 | 9 |
| RS Vulpec. | 13.4 | +22 16 | 6.9— 8.0 | 4 11.4 | 2 | 11 | 20 | 9 | 7 | 7 | 25 | 5 |
| U Sagittæ | 14.4 | +19 26 | 6.5— 9.0 | 3 09.1 | 9 | 3 | 22 | 16 | 5 | 4 | 18 | 17 |
| Z Vulpec. | 17.5 | +25 23 | 7.3— 8.5 | 2 10.9 | 8 | 19 | 23 | 12 | 7 | 6 | 21 | 23 |
| TT Lyræ | 24.3 | +41 30 | 9.4—11.6 | 5 05.8 | 8 | 6 | 18 | 17 | 3 | 11 | 19 | 5 |
| UZ Draconis | 26.1 | +68 44 | 9.0— 9.8 | 1 15.1 | 10 | 1 | 29 | 14 | 11 | 15 | 24 | 16 |
| SY Cygni | 19 42.7 | +32 28 | 10. —12 | 6 00.2 | 10 | 7 | 22 | 7 | 9 | 8 | 21 | 8 |
| WW Cygni | 20 00.6 | +41 18 | 9.3—13.4 | 3 07.6 | 11 | 9 | 24 | 15 | 13 | 13 | 26 | 19 |
| SW Cygni | 03.8 | +46 01 | 9. —11.7 | 4 13.8 | 6 | 21 | 25 | 4 | 7 | 21 | 26 | 4 |
| VW Cygni | 11.4 | +34 12 | 9.8—11.8 | 8 10.3 | 11 | 2 | 27 | 22 | 13 | 19 | 30 | 16 |
| RW Capric. | 12.2 | —17 59 | 8.8—10.6 | 3 09.4 | 4 | 21 | 18 | 11 | 7 | 19 | 21 | 9 |
| UW Cygni | 19.6 | +42 55 | 10.5—13 | 3 10.8 | 8 | 22 | 22 | 17 | 5 | 12 | 19 | 8 |
| V Vulpec | 32.3 | +26 15 | 8.2— 9.8 | 37 19.0 | 2 | 10 | | | 9 | 5 | | |
| W Delphini | 33.1 | +17 56 | 9.4—12.1 | 4 19.4 | 2 | 17 | 21 | 23 | 10 | 4 | 29 | 9 |
| RR Delphini | 38.9 | +13 35 | 10.5—11.8 | 4 14.4 | 7 | 5 | 25 | 15 | 3 | 20 | 22 | 5 |
| Y Cygni | 48.1 | +34 17 | 7.1— 7.9 | 1 12.0 | 3 | 14 | 21 | 13 | 8 | 13 | 26 | 12 |
| WZ Cygni | 49.3 | +38 27 | 9.9—10.8 | 0 14.0 | 7 | 3 | 22 | 7 | 6 | 12 | 21 | 17 |
| RR Vulpec | 20 50.5 | +27 32 | 9.6—11.0 | 5 01.2 | 3 | 2 | 23 | 7 | 2 | 10 | 22 | 14 |
| RY Aquarii | 21 14.8 | —11 14 | 8.8—10.4 | 1 23.2 | 6 | 15 | 22 | 8 | 7 | 2 | 22 | 20 |
| UZ Cygni | 55.2 | +43 52 | 8.9—11.6 | 31 07.3 | 9 | 23 | | | 10 | 6 | | |
| RT Lacertæ | 21 57.4 | +43 24 | 9.1—10.5 | 5 01.7 | 2 | 12 | 22 | 19 | 1 | 23 | 22 | 6 |
| RW Lacertæ | 22 40.6 | +49 08 | 10.2—11.2 | 5 04.4 | 4 | 22 | 20 | 11 | 10 | 5 | 25 | 18 |
| VW Pegasi | 51.7 | +32 42 | 10.0—10.6 | 5 06.4 | 6 | 18 | 22 | 13 | 7 | 9 | 17 | 22 |
| Y Piscium | 23 29.3 | + 7 22 | 9.0—12.0 | 3 18.4 | 3 | 7 | 18 | 8 | 9 | 22 | 25 | 0 |
| TW Androm. | 23 58.2 | +32 17 | 8.6—11.5 | 4 02.9 | 9 | 11 | 25 | 23 | 11 | 11 | 27 | 23 |

## Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard time 6h, etc.

| Star | R.A. 1900 | | Decl. 1900 | | Magnitude | Approx. Period | | Greenwich mean times of maxima in 1924 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | July | | | | August | | | |
| | h | m | ° | ′ | | d | h | d | h | d | h | d | h | d | h |
| SX Cassiop. | 0 | 05.5 | +54 | 20 | 8.6— 9.2 | 36 | 13.7 | | | 15 | 14 | | | 21 | 4 |
| SY Cassiop. | 0 | 09.8 | +57 | 52 | 9.3— 9.9 | 4 | 01.7 | 2 | 6 | 18 | 12 | 3 | 20 | 20 | 2 |
| RR Ceti | 1 | 27.0 | + 0 | 50 | 8.3— 9.0 | 0 | 13.3 | 5 | 22 | 21 | 10 | 5 | 21 | 21 | 9 |
| RW Cassiop. | 1 | 30.7 | +57 | 15 | 8.9—11.0 | 14 | 19.2 | 7 | 3 | 21 | 22 | 5 | 17 | 30 | 12 |
| V Arietis | 2 | 09.6 | +11 | 46 | 8.3— 9.0 | 0 | 23.8 | 6 | 20 | 22 | 18 | 7 | 15 | 23 | 12 |
| SU Cassiop. | 2 | 43.0 | +68 | 28 | 6.5— 7.0 | 1 | 22.8 | 6 | 21 | 22 | 12 | 7 | 2 | 22 | 16 |
| RW Camelop. | 3 | 46.2 | +58 | 21 | 8.2— 9.4 | 16 | 00.0 | 8 | 8 | 24 | 18 | 10 | 4 | 26 | 13 |
| SX Persei | 4 | 10.2 | +41 | 27 | 10.4—11.2 | 4 | 07.0 | 4 | 17 | 21 | 21 | 8 | 0 | 25 | 4 |
| SV Persei | | 42.8 | +42 | 07 | 8.8— 9.6 | 11 | 03.1 | 6 | 18 | 29 | 0 | 9 | 3 | 20 | 7 |
| RX Aurigæ | 4 | 54.5 | +39 | 49 | 7.2— 8.1 | 11 | 15.0 | 10 | 13 | 22 | 4 | 2 | 19 | 26 | 1 |
| SX Aurigæ | 5 | 04.6 | +42 | 02 | 8.0— 8.7 | 1 | 12.8 | 6 | 5 | 21 | 12 | 5 | 20 | 21 | 4 |
| SY Aurigæ | | 05.5 | +42 | 41 | 8.4— 9.5 | 10 | 03.3 | 9 | 13 | 29 | 19 | 8 | 23 | 29 | 5 |
| Y Aurigæ | | 21.5 | +42 | 21 | 8.6— 9.6 | 3 | 20.6 | 6 | 2 | 21 | 12 | 5 | 23 | 21 | 9 |
| RZ Gemin. | 5 | 56.6 | +22 | 15 | 9.1—10.0 | 5 | 12.7 | 8 | 11 | 25 | 1 | 5 | 2 | 21 | 16 |
| RS Orionis | 6 | 16.5 | +14 | 44 | 8.2— 8.9 | 7 | 13.6 | 5 | 5 | 20 | 9 | 12 | 1 | 27 | 5 |
| T Monoc. | | 19.8 | + 7 | 08 | 5.7— 6.8 | 27 | 00.3 | 9 | 12 | | | 5 | 12 | | |
| R Aurigæ | | 23.0 | +30 | 33 | 5.1— 6.0 | 3 | 17.5 | 6 | 11 | 21 | 8 | 5 | 6 | 20 | 4 |
| W Gemin. | | 29.2 | +15 | 24 | 6.7— 7.5 | 7 | 22.0 | 1 | 19 | 17 | 15 | 2 | 11 | 18 | 7 |
| ζ Gemin. | 6 | 58.2 | +20 | 43 | 3.7— 4.3 | 10 | 03.7 | 3 | 7 | 23 | 15 | 2 | 18 | 23 | 2 |
| RU Camelop | 7 | 10.9 | +69 | 51 | 8.5— 9.8 | 22 | 06.5 | | | 22 | 5 | 13 | 12 | | |
| RR Gemin. | 7 | 15.2 | +31 | 04 | 10.0—11.5 | 0 | 09.5 | 7 | 11 | 23 | 9 | 8 | 6 | 24 | 4 |
| V Carinae | 8 | 26.7 | —59 | 47 | 7.4— 8.1 | 6 | 16.7 | 11 | 3 | 24 | 12 | 6 | 22 | 20 | 7 |
| T Velorum | 8 | 34.4 | —47 | 01 | 7.6— 8.5 | 4 | 15.3 | 9 | 10 | 28 | 0 | 6 | 7 | 24 | 20 |
| V Velorum | 9 | 19.2 | —55 | 32 | 7.5— 8.2 | 4 | 08.9 | 6 | 6 | 23 | 17 | 10 | 5 | 27 | 17 |
| Z Leonis | 9 | 46.4 | +27 | 22 | 7.9— 9.6 | 56 | 08.7 | 10 | 19 | | | | | | |
| RR Leonis | 10 | 02.1 | +24 | 29 | 9.1—10.1 | 0 | 10.9 | 4 | 18 | 26 | 2 | 7 | 16 | 21 | 6 |
| SU Draconis | 11 | 32.2 | +67 | 53 | 8.9— 9.6 | 0 | 15.8 | 7 | 13 | 20 | 18 | 2 | 23 | 22 | 18 |
| S Muscae | 12 | 07.4 | —69 | 36 | 6.4— 7.3 | 9 | 15.8 | 4 | 13 | 23 | 21 | 2 | 13 | 21 | 20 |
| SW Draconis | | 12.8 | +70 | 04 | 8.8— 9.6 | 0 | 13.7 | 5 | 7 | 21 | 6 | 6 | 5 | 22 | 4 |
| T Crucis | | 15.9 | —61 | 44 | 6.8— 7.6 | 6 | 17.6 | 8 | 10 | 21 | 21 | 11 | 2 | 24 | 13 |
| R Crucis | | 18.1 | —61 | 04 | 6.8— 7.9 | 5 | 19.8 | 7 | 9 | 24 | 20 | 5 | 12 | 22 | 23 |
| S Crucis | 12 | 48.4 | —57 | 53 | 6.5— 7.6 | 4 | 16.6 | 8 | 6 | 22 | 7 | 5 | 9 | 19 | 11 |
| W Virginis | 13 | 20.9 | — 2 | 52 | 8.7—10.4 | 17 | 06.5 | 2 | 0 | 19 | 6 | 5 | 13 | 22 | 19 |
| SS Hydræ | | 25.0 | —23 | 08 | 7.4— 8.1 | 8 | 04.8 | 4 | 14 | 21 | 0 | 6 | 10 | 22 | 19 |
| RV Urs. Maj. | 13 | 29.4 | +54 | 31 | 9.2— 9.9 | 0 | 11.2 | 9 | 15 | 23 | 16 | 6 | 17 | 20 | 18 |
| ST Virginis | 14 | 22.5 | — 0 | 27 | 10.3—11.4 | 0 | 09.9 | 4 | 9 | 20 | 20 | 6 | 7 | 22 | 18 |
| V Centauri | | 25.4 | —56 | 27 | 6.4— 7.8 | 5 | 11.9 | 8 | 4 | 24 | 15 | 10 | 3 | 26 | 14 |
| RS Bootis | | 29.3 | +32 | 11 | 8.9—10.0 | 0 | 09.1 | 4 | 20 | 19 | 22 | 11 | 14 | 26 | 16 |
| R Triang.Austr. | 15 | 10.8 | —66 | 08 | 6.7— 7.4 | 3 | 09.3 | 9 | 4 | 22 | 17 | 5 | 6 | 18 | 20 |
| S Triang.Austr. | 15 | 52.2 | —63 | 29 | 6.4— 7.4 | 6 | 07.8 | 9 | 22 | 22 | 14 | 10 | 13 | 23 | 4 |
| S Normæ | 16 | 10.6 | —57 | 39 | 6.6— 7.6 | 9 | 18.1 | 5 | 12 | 25 | 0 | 3 | 18 | 23 | 6 |
| RW Draconis | | 33.7 | +58 | 03 | 9.6—10.8 | 0 | 10.6 | 4 | 15 | 22 | 8 | 9 | 1 | 26 | 19 |
| RV Scorpii | 16 | 51.8 | —33 | 27 | 6.7— 7.4 | 6 | 01.5 | 6 | 20 | 25 | 1 | 6 | 4 | 24 | 8 |
| X Sagittarii | 17 | 41.3 | —27 | 48 | 4.4— 5.0 | 7 | 00.3 | 7 | 1 | 21 | 2 | 4 | 2 | 18 | 3 |
| Y Ophiuchi | | 47.3 | — 6 | 07 | 6.1— 6.5 | 17 | 02.9 | | | 16 | 1 | 2 | 4 | 19 | 7 |
| W Sagittarii | 17 | 58.6 | —29 | 35 | 4.3— 5.1 | 7 | 14.3 | 3 | 1 | 18 | 5 | 2 | 10 | 25 | 5 |
| Y Sagittarii | 18 | 15.5 | —18 | 54 | 5.4— 6.2 | 5 | 18.6 | 3 | 13 | 23 | 20 | 4 | 10 | 21 | 17 |
| U Sagittarii | | 26.0 | —19 | 12 | 6.5— 7.3 | 6 | 17.9 | 6 | 4 | 19 | 16 | 8 | 21 | 22 | 9 |
| Y Scuti | | 32.6 | — 8 | 27 | 8.7— 9.2 | 10 | 08.3 | 7 | 1 | 27 | 18 | 7 | 2 | 27 | 18 |
| RZ Lyræ | | 39.9 | +32 | 42 | 9.9—11.2 | 0 | 12.3 | 11 | 3 | 23 | 10 | 10 | 20 | 23 | 2 |
| RT Scuti | 18 | 44.1 | —10 | 30 | 9.1— 9.7 | 0 | 11.9 | 7 | 3 | 19 | 1 | 5 | 21 | 23 | 17 |
| κ Pavonis | 18 | 46.6 | —67 | 22 | 3.8— 5.2 | 9 | 02.2 | 8 | 15 | 26 | 18 | 4 | 21 | 23 | 2 |
| U Aquilæ | 19 | 24.0 | — 7 | 15 | 6.2— 6.9 | 7 | 00.6 | 5 | 5 | 19 | 7 | 9 | 8 | 23 | 9 |
| XZ Cygni | 19 | 30.4 | +56 | 10 | 8.6— 9.3 | 0 | 11.2 | 6 | 19 | 20 | 19 | 10 | 19 | 24 | 19 |

**Maxima of Variable Stars of Short Period—Continued.**

| Star | R.A. 1900 | Decl. 1900 | Magnitude | Approx. Period | Greenwich mean times of maxima in 1924 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | July | | | | August | | | |
| | h m | ° ′ | | d h | d h | d h | d h | d h | d h | d h | d h | d h |
| U Vulpec. | 32.2 | +20 07 | 6.5— 7.6 | 7 23.5 | 8 19 | 24 18 | 9 17 | 25 16 | | | | |
| SU Cygni | 40.8 | +29 01 | 6.2— 7.0 | 3 20.3 | 3 16 | 19 1 | 11 3 | 26 12 | | | | |
| η Aquilæ | 47.4 | + 0 45 | 3.7— 4.5 | 7 04.2 | 3 0 | 24 3 | 7 21 | 22 6 | | | | |
| S Sagittæ | 51.5 | +16 22 | 5.6— 6.4 | 8 09.2 | 2 13 | 19 8 | 5 2 | 21 20 | | | | |
| X Vulpec. | 19 53.3 | +26 17 | 9.5—10.5 | 6 07.7 | 5 15 | 24 14 | 6 5 | 25 4 | | | | |
| X Cygni | 20 39.5 | +35 14 | 6.0— 7.0 | 16 09.3 | 3 20 | 20 5 | 5 15 | 22 0 | | | | |
| T Vulpec. | 47.2 | +27 52 | 5.5— 6.1 | 4 10.5 | 9 5 | 22 12 | 9 6 | 22 13 | | | | |
| UY Cygni | 52.3 | +30 03 | 9.6—10.4 | 0 13.5 | 7 14 | 21 1 | 10 6 | 23 17 | | | | |
| RV Capric. | 55.9 | —15 37 | 9.2—10.1 | 0 10.7 | 7 2 | 20 12 | 2 22 | 23 2 | | | | |
| TX Cygni | 20 56.4 | +42 12 | 8.5— 9.7 | 14 17.4 | 1 8 | 30 18 | 14 11 | 29 4 | | | | |
| VY Cygni | 21 00.4 | +39 34 | 8.8— 9.5 | 7 20.6 | 11 17 | 27 10 | 4 7 | 20 0 | | | | |
| SW Aquarii | 10.2 | — 0 20 | 9.9—10.8 | 0 11.0 | 6 21 | 20 16 | 3 10 | 24 3 | | | | |
| VZ Cygni | 21 47.7 | +42 40 | 8.2— 9.2 | 4 20.7 | 6 12 | 21 2 | 9 13 | 24 3 | | | | |
| Y Lacertæ | 22 05.2 | +50 33 | 9.1— 9.6 | 4 07.8 | 7 2 | 24 10 | 10 17 | 28 0 | | | | |
| δ Cephei | 25.5 | +57 54 | 3.7— 4.6 | 5 08.8 | 7 14 | 23 16 | 8 18 | 24 21 | | | | |
| Z Lacertæ | 36.9 | +56 18 | 8.2— 9.0 | 10 21.1 | 8 11 | 30 6 | 10 3 | 21 1 | | | | |
| RR Lacertæ | 37.5 | +55 55 | 8.5— 9.2 | 6 10.1 | 7 0 | 19 20 | 8 1 | 20 21 | | | | |
| V Lacertæ | 44.5 | +55 48 | 8.5— 9.5 | 4 23.6 | 5 9 | 25 7 | 9 6 | 24 5 | | | | |
| X Lacertæ | 22 45.0 | +55 54 | 8.2— 8.6 | 5 10.7 | 8 10 | 24 18 | 4 16 | 21 0 | | | | |
| SW Cassiop. | 23 03.7 | +58 11 | 9.2— 9.7 | 5 10.6 | 11 4 | 27 12 | 7 9 | 23 16 | | | | |
| RS Cassiop. | 32.6 | +61 52 | 9.0—11.0 | 6 07.1 | 8 19 | 21 10 | 9 7 | 21 21 | | | | |
| RY Cassiop. | 47.2 | +58 11 | 9.3—11.8 | 12 03.4 | 1 11 | 25 18 | 6 21 | 31 3 | | | | |
| V Cephei | 23 51.7 | +82 38 | 6.0— 7.0 | 0 23.9 | 8 0 | 21 23 | 4 22 | 18 22 | | | | |

## Monthly Report of the American Association of Variable Star Observers, February 20 to April 20, 1924.

The wide geographical distribution of observers has resulted in securing most valuable observations of all three SS Cygni type variables, observations having been obtained during the recent maxima on the rapidly rising phase of each of these stars.

Attention is callled by Mr. G. H. Lepper to the variation of Hagen 25 in the region of V Bootis, 142539. This star follows the variable by 48 seconds and is 8 minutes of arc south. It has a range of about 0.8 magnitude, and is a good star to be observed by our more experienced observers.

Mr. Sigeru Kanda deserves more than passing mention for his excellent paper dealing with the "Large Irregularity in the Period of AF Cygni, and its New Elements." He has presented a clear, concise discussion of the period of this hitherto troublesome variable, and added much to our knowledge of the action of this type of star.

It is a pleasure to note that our Mr. Skaggs of Oakland, California, has arranged with Professor Linsley, director of the Chabot Observatory, for the use of the 20-inch telescope in observing the faint variables. This is a marked concession to be made to one of our diligent observers and it is hoped that the advantage may be mutual.

Mr. S. B. Cummings, Norway, Maine, has collected a set of fifty enlargements of astronomical views (17″ x 20″), neatly packed in a portfolio and case, which he offers to loan to members who will defray the cost of expressage and return them in a reasonable time, in equally good condition. Such a set would be of particular interest in schools, or libraries, or when giving informal astronomical talks.

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924.

February 0 = J. D. 2423816. March 0 = J. D. 2423845.
April 0 = J. D. 2423876.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| *000339* V SCULPTORIS— | | | | | | |
| | 3798.0 | 10.6 | Bl, | 3815.0 | 11.8 | Bl, |
| | 3806.0 | 10.7 | Bl, | 3840.9 | 12.9 | Bl. |
| *001032* S SCULPTORIS— | | | | | | |
| | 3798.0 | 7.4 | Bl, | 3822.0 | 8.4 | Bl, |
| | 3806.0 | 7.2 | Bl, | 3842.9 | 9.5 | Bl. |
| | 3815.0 | 8.2 | Bl, | | | |
| 001046 X ANDROMEDAE— | | | | | | |
| | 3835.6 | 13.0 | Wf, | 3883.6 | 13.5 | Wf. |
| | 3838.5 | 12.9 | Lv. | | | |
| *001620* T CETI— | | | | | | |
| | 3813.9 | 6.5 | Kd, | 3820.9 | 6.6 | Kd, |
| | 3817.9 | 6.5 | Kd, | 3823.9 | 6.5 | Kd. |
| 001726 T ANDROMEDAE— | | | | | | |
| | 3829.0 | 9.0 | Ch, | 3841.5 | 8.4 | Pt, |
| | 3834.5 | 8.7 | Ie, | 3842.0 | 8.7 | Ch, |
| | 3835.1 | 8.8 | Ch, | 3847.0 | 8.6 | Ch, |
| | 3839.5 | 8.7 | Lv. | 3847.5 | 8.7 | Ie. |
| 001755 T CASSIOPEIAE— | | | | | | |
| | 3839.5 | 11.8 | B, | 3849.5 | 11.4 | B, |
| | 3840.7 | 11.6 | Sσ, | 3871.5 | 12.0 | Pt. |
| | 3841.5 | 11.6 | Pt, | | | |
| 001838 R ANDROMEDAE— | | | | | | |
| | 3829.1 | 10.0 | Ch, | 3844.6 | 8.1 | Sσ. |
| | 3837.5 | 9.4 | Cd, | 3847.5 | 8.0 | Ie, |
| | 3838.1 | 9.5 | Ch, | 3850.1 | 7.6 | Ch, |
| | 3838.5 | 9.2 | Cy | 3855.0 | 7.5 | Ch, |
| | 3839.5 | 9.2 | Cy, | 3868.5 | 6.5 | Ie, |
| | 3841.5 | 9.0 | Pt, | 3871.5 | 6.2 | Pt. |
| | 3843.0 | 9.0 | Ch, | | | |
| *001862* S TUCANAE— | | | | | | |
| | 3815.0 | 11.0 | Bl, | 3840.9 | 10.0 | Bl. |
| | 3822.0 | 10.6 | Bl, | | | |
| *002546* T PHOENICIS— | | | | | | |
| | 3815.0 | 13.9 | Bl. | | | |
| *002833* W SCULPTORIS— | | | | | | |
| | 3815.0 | 13.0 | Bl, | 3842.9 | 13.2 | Bl. |
| 003179 Y CEPHEI— | | | | | | |
| | 3858.7 | 11.6 | Br, | 3882.7 | 12.4 | Br. |
| 004047 U CASSIOPEIAE— | | | | | | |
| | 3835.6 | 8.3 | Wf, | 3845.6 | 8.4 | Wf, |
| | 3837.7 | 8.6 | Sg, | 3849.7 | 8.4 | Sg, |
| | 3838.5 | 8.4 | Lv, | 3863.6 | 9.5 | Lv, |
| | 3838.5 | 8.4 | Ie, | 3869.5 | 9.8 | Ie, |
| | 3839.5 | 8.1 | B, | 3871.5 | 9.3 | Pt, |
| | 3839.6 | 8.2 | Y, | 3883.6 | 10.8 | Wf. |
| | 3841.5 | 8.1 | Pt, | | | |
| *004435* X SCULPTORIS— | | | | | | |
| | 3815.0 | 14.0 | Bl, | 3842.9 | 12.9 | Bl. |
| 004746 RV CASSIOPEIAE— | | | | | | |
| | 3841.5 | 13.0 | Pt, | 3883.6 | 14.5 | Wf. |
| | 3849.6 | 12.2 | B, | | | |
| 004958 W CASSIOPEIAE— | | | | | | |
| | 3839.5 | 8.5 | B, | 3871.5 | 8.6 | Pt. |
| | 3841.5 | 8.9 | Pt, | | | |
| *005475* U TUCANAE— | | | | | | |
| | 3798.0 | 8.7 | Bl, | 3822.0 | 9.0 | Bl, |
| | 3806.0 | 8.6 | Bl, | 3840.9 | 10.0 | Bl. |
| | 3815.0 | 8.8 | Bl, | | | |
| *010630* U SCULPTORIS— | | | | | | |
| | 3798.0 | 12.1 | Bl, | 3815.0 | 13.5 | Bl. |
| 010940 U ANDROMEDAE— | | | | | | |
| | 3845.5 | 12.8 | Ie, | 3849.5 | 13.0 | B. |
| 011041 UZ ANDROMEDAE— | | | | | | |
| | 3838.6 | 11.8 | Ie, | 3883.6 | 13.4 | Wf. |
| | 3844.5 | 12.1 | B, | | | |
| 011272 S CASSIOPEIAE— | | | | | | |
| | 3839.6 | 12.7 | Lv, | 3863.6 | 13.0 | Lv, |
| | 3841.5 | 12.9 | Pt, | 3869.6 | 13.4 | Ie, |
| | 3842.7 | 13.5 | Sg, | 3871.5 | 13.8 | Pt, |
| | 3845.5 | 12.8 | Ie, | 3877.7 | 13.4 | Sg. |
| | 3858.7 | 13.0 | Br, | 3881.6 | 13.5 | Lv. |
| 011712 U PISCIUM— | | | | | | |
| | 3841.5 | 11.5 | Pt. | | | |
| *012233a* R SCULPTORIS— | | | | | | |
| | 3823.9 | 7.3 | Kd. | | | |
| 012350 RZ PERSEI— | | | | | | |
| | 3839.6 | 9.9 | B, | 3839.6 | 9.8 | Y. |
| 012502 R PISCIUM— | | | | | | |
| | 3841.5 | 12.2 | Lv. | | | |
| 013238 RU ANDROMEDAE— | | | | | | |
| | 3825.2 | 9.8 | Ch, | 3848.1 | 9.8 | Ch, |
| | 3839.1 | 9.8 | Ch, | 3852.1 | 10.2 | Ch, |
| | 3841.5 | 9.7 | Pt, | 3871.5 | 11.3 | Pt, |
| | 3842.6 | 10.0 | Ie, | 3883.7 | 12.4 | Wf. |
| | 3844.5 | 10.4 | B, | | | |
| 013338 Y ANDROMEDAE— | | | | | | |
| | 3839.1 | 9.9 | Ch, | 3848.1 | 9.2 | Ch, |
| | 3841.5 | 9.6 | Pt, | 3852.1 | 9.0 | Ch, |
| | 3844.6 | 9.8 | B, | 3871.5 | 8.4 | Pt. |
| 014958 X CASSIOPEIAE— | | | | | | |
| | 3839.6 | 12.3 | B, | 3841.5 | 12.0 | Pt, |
| | 3846.6 | 12.7 | B. | 3871.5 | 12.6 | Pt. |
| 015354 U PERSEI— | | | | | | |
| | 3838.6 | 8.8 | B, | 3868.7 | 9.2 | Sg, |
| | 3841.5 | 8.8 | Pt, | 3871.5 | 9.8 | Pt, |
| | 3842.7 | 9.0 | Ca, | 3873.5 | 9.6 | Ca, |
| | 3843.7 | 8.8 | Sg, | 3882.7 | 9.5 | Sg, |
| | 3857.6 | 9.3 | Ca, | 3889.6 | 9.6 | Kl. |
| 015912 S ARIETIS— | | | | | | |
| | 3841.6 | 11.0 | Pt. | | | |
| 021024 R ARIETIS— | | | | | | |
| | 3838.6 | 12.6 | Lv, | 3846.5 | 12.8 | B, |
| | 3839.6 | 13.0 | B, | 3866.6 | 11.4 | Lv, |
| | 3841.6 | 13.0 | Pt, | 3867.5 | 11.2 | Ca. |
| | 3841.6 | 12.5 | Lv, | | | |
| 021143a W ANDROMEDAE— | | | | | | |
| | 3841.6 | 11.7 | Pt, | 3868.5 | 12.1 | Ie, |
| | 3844.6 | 10.8 | B, | 3871.5 | 12.0 | Pt. |
| | 3847.6 | 10.9 | Ie, | | | |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est.Obs. | J.D. | Est.Obs. |
|---|---|---|---|---|
| 021258 T PERSEI— | | | | |
| | 3839.6 | 8.6 B, | 3849.6 | 8.5 B, |
| | 3841.6 | 8.5 Pt, | 3852.2 | 8.5 Ch, |
| | 3842.6 | 8.8 Ya, | 3871.5 | 8.5 Pt. |
| | ?843.1 | 8.8 Ch, | | |
| 021281 Z CEPHEI— | | | | |
| | 3883.7 | 15.0 Wf. | | |
| *021403* o CETI— | | | | |
| | 3811.9 | 5.1 Kd, | 3836.9 | 5.5 Kd, |
| | 3811.9 | 5.5 Kd, | 3837.7 | 4.5 Sg, |
| | 3812.9 | 5.0 Kd, | 3838.5 | 5.2 Cy, |
| | 3812.9 | 5.6 Kd, | 3839.5 | 4.8 Cy, |
| | 3813.9 | 4.9 Kd, | 3840.0 | 5.0 Ch, |
| | 3813.9 | 5.4 Kd, | 3841.5 | 4.8 Ca, |
| | 3814.9 | 4.9 Kd, | 3841.6 | 4.8 Pt, |
| | 3814.9 | 5.6 Kd | 3849.1 | 5.0 Kd, |
| | 3817.9 | 4.9 Kd, | 3841.9 | 5.6 Kd, |
| | 3817.9 | 5.4 Kd, | 3845.0 | 5.0 Ch, |
| | 3819.0 | 4.9 Kd, | 3845.5 | 4.4 Cy, |
| | 3819.0 | 5.4 Kd, | 3846.5 | 4.9 Co, |
| | 3819.9 | 5.0 Kd, | 3847.6 | 4.2 Sg, |
| | 3819.9 | 5.6 Kd, | 3847.9 | 5.6 Kd, |
| | 3820.9 | 4.9 Kd, | 3848.1 | 5.2 Ch, |
| | 3820.9 | 5.7 Kd, | 3848.6 | 4.5 Ly, |
| | 3822.0 | 5.0 Ch, | 3850.1 | 5.1 Ch, |
| | 3823.9 | 5.7 Kd, | 3851.5 | 5.2 Ly, |
| | 3828.1 | 5.0 Ch, | 3851.9 | 5.7 Kd, |
| | 3828.9 | 4.8 Kd, | 3852.9 | 5.7 Kd, |
| | 3828.9 | 5.5 Kd, | 3853.1 | 5.0 Ch, |
| | 3830.1 | 5.1 Ch, | 3854.9 | 5.7 Kd, |
| | 3831.0 | 5.5 Kd. | 3858.1 | 5.1 Ch, |
| | 3831.9 | 5.6 Kd. | 3858.5 | 5.5 Ly, |
| | 3832.9 | 5.7 Kd, | 3858.9 | 5.6 Kd, |
| | 3833.9 | 5.5 Kd, | 3859.9 | 5.6 Kd, |
| | 3835.1 | 5.1 Ch, | 3860.6 | 4.3 Kl, |
| | 3835.9 | 5.5 Kd. | 3867.5 | 6.2 Ly. |
| 021558 S PERSEI— | | | | |
| | 3841.6 | 8.5 Pt, | 3852.1 | 8.6 Ch, |
| | 3842.6 | 8.5 Ya, | 3889.6 | 8.9 Kl. |
| | 3843.1 | 8.4 Ch, | | |
| 022000 R CETI— | | | | |
| | 3839.0 | 9.8 Ch, | 3841.5 | 9.4 Ca, |
| | 3841.1 | 8.5 Ch, | 3853.1 | 8.4 Ch. |
| 022150 RR PERSEI— | | | | |
| | 3838.6 | 11.1 Ie, | 3871.5 | 8.9 Pt, |
| | 3841.6 | 10.8 Pt, | 3883.7 | 8.6 Wf. |
| | 3868.5 | 9.0 Ie, | | |
| *022426* R FORNACIS— | | | | |
| | 3798.0 | 10.5 Bl, | 3822.0 | 11.1 Bl, |
| | 3806.0 | 10.5 Bl, | 3840.9 | 11.9 Bl. |
| | 3815.0 | 11.0 Bl, | | |
| *022813* U CETI— | | | | |
| | 3830.1 | 7.7 Ch, | 3844.1 | 7.5 Ch, |
| | 3839.0 | 7.6 Ch, | 3853.1 | 8.1 Ch. |
| | 3841.6 | 7.6 Pt, | | |
| 022980 RR CEPHEI— | | | | |
| | 3852.8 | 15.5 Pa, | 3883.7 | 14.5 Wf, |
| | 3865.8 | 15. Pa. | 3893.8 | [14.0 Pa. |
| 023133 R TRIANGULI— | | | | |
| | 3814.9 | 8.7 Kd, | 3859.0 | 6.1 Kd, |
| | 3834.5 | 8.0 Ie, | 3859.9 | 6.0 Kd, |
| | 3839.5 | 8.1 Cy, | 3863.6 | 6.1 Lv, |
| | 3839.6 | 7 9 B, | 3863.9 | 6.0 Kd, |
| | 3839.6 | 7.5 Lv, | 3867.9 | 6.1 Kd, |
| | 3839.6 | 7.6 Ya, | 3868.5 | 6.0 Ie, |
| | 3841.9 | 7.7 Kd, | 3869.6 | 6.0 Ya, |
| | 3845.5 | 7.8 Cy, | 3871.6 | 6.3 Pt, |
| | 3847.6 | 6.7 Ie, | 3871.9 | 5.9 Kd, |
| | 3849.6 | 7.1 B, | 3879.5 | 6.0 Ie, |
| | 3859.1 | 6.9 Kd, | 3879.6 | 6.2 Lv. |
| | 3852.9 | 6.6 Kd, | | |
| 024356 W PERSEI— | | | | |
| | 3838.5 | 10.2 Cm, | 3871.6 | 9.4 Pt, |
| | 3839.6 | 10.1 Cy, | 3872.6 | 10.2 Ya, |
| | 3839.6 | 9.2 B, | 3872.7 | 10.0 Hr, |
| | 3839.6 | 10.0 Hr, | 3872.7 | 10.0 Cy, |
| | 3841.6 | 9.4 Pt, | 3881.6 | 10.2 Cy, |
| | 3849.6 | 9.1 B. | 3884.6 | 10.0 Cy. |
| | 3857.6 | 9.6 Ca, | 3884.6 | 10.1 Hr, |
| | 3861.5 | 10.0 M, | 3886.6 | 9.9 Ca, |
| | 3868.6 | 10.3 Cy, | 3889.6 | 9.6 Kl. |
| | 3869.5 | 9.6 Ca, | | |
| *025050* R HOROLOGII— | | | | |
| | 3798.0 | 10.9 Bl, | 3822.0 | 11.9 Bl, |
| | 3806.0 | 11.0 Bl, | 3840.9 | 12.4 Bl. |
| | 3815.0 | 11.4 Bl, | | |
| *025751* T HOROLOGII— | | | | |
| | 3815.0 | 13.3 Bl. | | |
| *031401* X CETI— | | | | |
| | 3840.5 | 9.6 Ca, | 3859.3 | 10.6 L. |
| | 3841.6 | 9.1 Pt, | | |
| 032043 Y PERSEI— | | | | |
| | 3841.6 | 9.8 Pt, | 3871.6 | 9.4 Pt, |
| | 3849.6 | 10.0 B, | 3883.6 | 10.5 B. |
| 032335 R PERSEI— | | | | |
| | 3841.6 | 14.2 Pt. | 3885.6 | 11.5 Kl. |
| | 3867.5 | 12.6 Ca, | 3886.5 | 12.1 Ca. |
| | 3869.6 | 12.5 B, | | |
| 042209 R TAURI— | | | | |
| | 3870.6 | 13.1 B. | | |
| 042215 W TAURI— | | | | |
| | 3810.6 | 10.1 Fi, | 3848.6 | 9.8 Sg, |
| | 3816.6 | 10.0 Fi, | 3860.7 | 9.8 Sg, |
| | 3837.7 | 9.5 Sg, | 3861.6 | 10.0 M, |
| | 3838.6 | 9.2 Cy, | 3868.6 | 9.8 Cy, |
| | 3838.6 | 9.5 B, | 3868.7 | 10.0 Sg, |
| | 3841.6 | 9.1 Pt, | 3871.6 | 9.2 Pt, |
| | 3845.6 | 9.5 Ya, | 3873.6 | 9.7 B. |
| | 3845.6 | 9.5 Cy, | 3875.5 | 9.9 Ya, |
| | 3846.6 | 9.8 Hr, | 3875.6 | 10.0 Cy, |
| | 3846.6 | 9.5 B, | 3877.7 | 10.0 Sg, |
| | 3847.6 | 9.9 Kl, | 3878.6 | 10.5 Kl. |
| 042309 S TAURI— | | | | |
| | 3883.6 | 11.0 Kl. | | |
| 043065 T CAMELOPARDALIS— | | | | |
| | 3841.6 | 11.5 Pt, | 3871.6 | 9.7 Pt. |
| | 3861.6 | 10.5 L, | | |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 043208 RX TAURI— | | | | | | |
| | 3816.6 | 11.9 | Fi, | 3863.6 | 10.0 | Lv, |
| | 3837.6 | 11.2 | Lv, | 3867.6 | 9.4 | B, |
| | 3838.6 | 11.0 | B, | 3871.6 | 9.5 | Pt, |
| | 3841.6 | 10.7 | Lv, | 3878.6 | 9.4 | Mn, |
| | 3844.6 | 11.0 | B, | 3881.6 | 9.2 | B. |
| *043263* R RETICULAE— | | | | | | |
| | 3798.0 | 11.6 | Bl, | 3822.0 | 10.3 | Bl, |
| | 3806.0 | 11.2 | Bl, | 3841.0 | 8.1 | Bl. |
| | 3815.0 | 10.7 | Bl. | | | |
| 043274 X CAMELOPARDALIS— | | | | | | |
| | 3841.6 | 10.5 | Pt, | 3870.6 | 13.0 | B, |
| | 3844.6 | 10.8 | B, | 3871.6 | 12.5 | Pt. |
| | 3845.6 | 10.8 | Ya, | | | |
| *043562* R DORADUS— | | | | | | |
| | 3806.0 | 5.0 | Bl, | 3841.0 | 5.2 | Bl. |
| *044349* R PICTORIS— | | | | | | |
| | 3798.0 | 8.0 | Bl, | 3822.0 | 7.7 | Bl, |
| | 3806.0 | 7.7 | Bl, | 3841.0 | 8.0 | Bl. |
| | 3815.0 | 8.0 | Bl, | | | |
| 044617 V TAURI— | | | | | | |
| | 3839.6 | 13.5 | B, | 3870.6 | 10.4 | B. |
| | 3846.6 | 12.9 | B, | 3883.6 | 10.3 | B. |
| | 3868.6 | 10.3 | Ie, | | | |
| 045307 R ORIONIS— | | | | | | |
| | 3838.6 | 12.7 | B, | 3873.6 | 13.3 | B. |
| | 3839.6 | 13.2 | Y, | | | |
| *045514* R LEPORIS— | | | | | | |
| | 3830.1 | 8.6 | Ch, | 3851.5 | 9.2 | Ly, |
| | 3839.6 | 8.9 | Ly, | 3853.1 | 9.3 | Ch, |
| | 3839.6 | 10.8 | Y, | 3859.3 | 8.2 | L, |
| | 3840.5 | 8.2 | Ca, | 3867.6 | 9.4 | Ly, |
| | 3841.6 | 7.5 | Pt, | 3871.5 | 8.2 | Pt, |
| | 3842.5 | 9.0 | Ly, | 3873.6 | 9.0 | B, |
| | 3844.1 | 9.0 | Ch, | 3875.5 | 9.7 | Ya, |
| | 3845.6 | 8.5 | Ya, | 3876.5 | 9.7 | Ly, |
| | 3848.6 | 9.1 | Ly, | 3884.6 | 9.3 | B. |
| 050003 V ORIONIS— | | | | | | |
| | 3838.6 | 11.3 | Ie, | 3853.2 | 10.4 | Ch, |
| | 3838.6 | 11.6 | B, | 3867.6 | 9.8 | B, |
| | 3841.6 | 10.9 | Pt, | 3868.5 | 9.8 | Ie, |
| | 3844.2 | 10.7 | Ch, | 3869.6 | 9.8 | Ya, |
| | 3846.6 | 10.9 | B, | 3871.5 | 9.8 | Pt, |
| | 3847.6 | 10.6 | Ya, | 3881.6 | 9.8 | B. |
| *050022* T LEPORIS— | | | | | | |
| | 3798.0 | 7.3 | Bl, | 3841.6 | 8.6 | Pt, |
| | 3806.0 | 7.4 | Bl, | 3871.5 | 9.9 | Pt, |
| | 3815.0 | 7.4 | Bl, | 3873.6 | 9.5 | B, |
| | 3822.0 | 8.4 | Bl, | 3884.6 | 9.1 | B. |
| | 3841.0 | 8.9 | Bl, | | | |
| *050848* S PICTORIS— | | | | | | |
| | 3798.0 | 8.0 | Bl, | 3822.0 | 9.1 | Bl, |
| | 3806.0 | 8.6 | Bl, | 3841.0 | 9.6 | Bl. |
| | 3815 0 | 8.5 | Bl, | | | |
| 050953 R AURIGAE— | | | | | | |
| | 3838.6 | 7.7 | Ie, | 3865.7 | 8.2 | Ca, |
| | 3839.7 | 8.2 | Lv, | 3871.6 | 9.7 | Pt, |
| | 3841.6 | 8.4 | Pt, | 3872.6 | 8.5 | B. |

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 050953 R AURIGAE—Continued | | | | | | |
| | 3841.7 | 8.1 | Ca, | 3872.7 | 8.2 | Lv, |
| | 3846.7 | 8.0 | Ca, | 3876.5 | 7.6 | Ie, |
| | 3847.6 | 8.4 | Ya. | 3879.6 | 8.6 | Ca, |
| | 3848.2 | 8.1 | Ch, | 3879.6 | 8.5 | Ya, |
| | 3852.7 | 8.2 | Lv, | 3881.6 | 8.7 | Lv, |
| | 3854.6 | 8.0 | Ie, | 3883.7 | 8.3 | Kl, |
| | 3856.7 | 8.3 | Ca, | 3887.6 | 8.7 | Ca. |
| | 3861.6 | 7.4 | M, | | | |
| *051247* T PICTORIS— | | | | | | |
| | 3798.0 | 10.2 | Bl, | 3822.0 | 9.1 | Bl, |
| | 3806.0 | 9.7 | Bl, | 3841.0 | 8.4 | Bl. |
| | 3815.0 | 9.8 | Bl, | | | |
| *051533* T COLUMBAE— | | | | | | |
| | 3815.0 | 10.9 | Bl, | 3841.0 | 9.5 | Bl. |
| 052034 S AURIGAE— | | | | | | |
| | 3837.8 | 9.9 | Sg, | 3868.7 | 10.4 | Sg, |
| | 3841.6 | 9.1 | Pt, | 3870.2 | 10.8 | Ch, |
| | 3842.7 | 10.9 | Sg, | 3871.6 | 8.6 | Pt, |
| | 3844.2 | 10.8 | Ch, | 3873.6 | 9.7 | B, |
| | 3847.6 | 9.3 | Ya, | 3879.6 | 10.3 | Ya, |
| | 3848.8 | 10.1 | Sg, | 3883.7 | 10.0 | Kl, |
| | 3850.7 | 10.8 | Sg, | 3892.6 | 9.2 | B. |
| | 3859.3 | 9.4 | L, | | | |
| *052404* S ORIONIS— | | | | | | |
| | 3838.6 | 10.4 | B, | 3857.5 | 11.5 | Ca, |
| | 3840.5 | 11.5 | Ca, | 3867.6 | 11.0 | B, |
| | 3841.6 | 11.1 | Pt | 3871.6 | 12.2 | Pt. |
| | 3846.6 | 10.8 | B, | 3883.6 | 12.3 | B, |
| | 3853.5 | 12.0 | Pt, | 3885.5 | 13.0 | Pt. |
| *053005a* T ORIONIS— | | | | | | |
| | 3838.6 | 11.0 | B, | 3867.5 | 11.3 | B, |
| | 3841.6 | 10.7 | Pt, | 3869.6 | 11.0 | Ya, |
| | 3842.5 | 10.6 | Pt, | 3871.6 | 10.6 | Pt, |
| | 3843.5 | 10.5 | Pt, | 3872.3 | 11.8 | L, |
| | 3847.6 | 10.5 | Ya, | 3878.5 | 10.6 | Pt, |
| | 3848.5 | 10.2 | Pt, | 3878.6 | 11.1 | B, |
| | 3849.6 | 11.3 | B, | 3880.5 | 10.6 | Pt, |
| | 3850.5 | 10.2 | Pt, | 3881.6 | 11.1 | B, |
| | 3853.5 | 10.3 | Pt, | 3882.5 | 10.5 | Pt, |
| | 3857.6 | 10.4 | Pt, | 3883.6 | 10.3 | Kl, |
| | 3858.5 | 10.3 | Pt, | 3885.5 | 10.5 | Pt, |
| | 3859.3 | 11.2 | L, | 3886.5 | 10.3 | Pt, |
| | 3860.3 | 11.5 | L, | 3887.5 | 10.4 | Pt, |
| | 3861.3 | 10.8 | L, | 3891.6 | 10.4 | Pt. |
| | 3864.5 | 10.3 | Pt, | | | |
| 053068 S CAMELOPARDALIS— | | | | | | |
| | 3841.6 | 9.7 | Pt, | 3869.6 | 10.5 | Ya, |
| | 3847.6 | 9.8 | Ya, | 3871.6 | 9.9 | Pt. |
| 053326 RR TAURI— | | | | | | |
| | 3848.6 | 12.0 | B, | 3867.6 | 12.5 | B. |
| 053337 RU AURIGAE— | | | | | | |
| | 3837.8 | 9.8 | Sg, | 3868.7 | 9.5 | Sg, |
| | 3841.6 | 9.7 | Pt, | 3871.6 | 9.5 | Pt. |
| | 3848.8 | 9.7 | Sg, | | | |
| 053531 U AURIGAE— | | | | | | |
| | 3841.6 | 13.2 | Pt, | 3871.6 | 13.1 | Pt. |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 054319 SU TAURI— | | | | | | |
| | 3834.6 | 9.4 | Br, | 3861.7 | 9.6 | Pt, |
| | 3835.6 | 9.5 | Wf, | 3864.5 | 9.6 | Pt, |
| | 3836.3 | 9.8 | Ch, | 3866.6 | 9.6 | Lv, |
| | 3837.5 | 9.4 | Cd, | 3867.5 | 9.5 | B, |
| | 3837.6 | 9.6 | Lv, | 3867.6 | 9.5 | Ie, |
| | 3838.6 | 9.5 | B, | 3868.1 | 9.7 | Ch, |
| | 3839.5 | 9.4 | Ie, | 3868.6 | 9.4 | Ly, |
| | 3841.6 | 9.5 | Pt, | 3870.7 | 9.5 | Br, |
| | 3842.5 | 9.6 | Pt, | 3871.6 | 9.5 | Pt, |
| | 3843.5 | 9.6 | Pt, | 3873 6 | 9.6 | Ly, |
| | 3843 6 | 9.5 | Lv, | 3873.6 | 9.5 | B, |
| | 3844.2 | 9.7 | Ch, | 3878.5 | 9.6 | Pt, |
| | 3845.5 | 9.6 | Y, | 3878.6 | 9.5 | B, |
| | 3845.7 | 9.4 | Br, | 3879.5 | 9.6 | Pt, |
| | 3846.8 | 9 6 | Pt, | 3879.7 | 9.5 | Br, |
| | 3848.5 | 9.6 | Pt, | 3880.5 | 9.6 | Pt, |
| | 3849.6 | 9.5 | B, | 3881.6 | 9.3 | Lv, |
| | 3849.7 | 9.4 | Br, | 3881.7 | 9.4 | Br, |
| | 3850.5 | 9.6 | Pt, | 3882.5 | 9.6 | Pt, |
| | 3850.6 | 9.4 | Br, | 3882.7 | 9.5 | Br, |
| | 3852 6 | 9.4 | Lv, | 3883.7 | 9.5 | Wf, |
| | 3852.7 | 9.7 | Br, | 3883.7 | 9.4 | Br, |
| | 3853.5 | 9.6 | Pt, | 3885.5 | 9.6 | Pt, |
| | 3855.2 | 9.7 | Ch, | 3886.5 | 9.6 | Pt, |
| | 3855.7 | 9.6 | Br, | 3887.5 | 9.5 | Pt, |
| | 3857.4 | 9.4 | L, | 3890.5 | 9.5 | Ie, |
| | 3857.6 | 9.6 | Pt, | 3891.6 | 9.5 | Pt, |
| | 3860.3 | 9.4 | L, | 3892.6 | 9.5 | B. |
| | 3861.3 | 9.3 | L, | | | |
| *054331* S COLUMBAE— | | | | | | |
| | 3842.0 | 13.0 | Bl. | | | |
| 054615a Z TAURI— | | | | | | |
| | 3839.5 | 13.8 | Ie. | | | |
| 054615c RU TAURI— | | | | | | |
| | 3839.6 | 11.0 | Ie, | 3867.6 | 11.0 | Ie. |
| 054920a U ORIONIS— | | | | | | |
| | 3839.6 | 11.3 | Cy, | 3867.5 | 11.1 | Ca, |
| | 3837.6 | 11.0 | Lv, | 3867.6 | 10.6 | B, |
| | 3840.7 | 11.0 | Sg, | 3868.1 | 11.5 | Ch, |
| | 3841.6 | 11.1 | Pt, | 3868.6 | 11.6 | Cy, |
| | 3842.6 | 11.2 | Ca, | 3871.6 | 11.5 | Pt, |
| | 3843.6 | 11.3 | Lv, | 3872.6 | 11.5 | Ya, |
| | 3847.6 | 10.2 | Ya, | 3872.8 | 11.5 | Cy, |
| | 3848.6 | 10.5 | B, | 3876.6 | 10.5 | Gb, |
| | 3849.7 | 10 7 | Gb, | 3879.6 | 11.7 | Lv, |
| | 3850.7 | 10.5 | Sg, | 3882.7 | 11.5 | Sg, |
| | 3852.6 | 11.1 | Lv, | 3883.6 | 11.3 | Kl, |
| | 3853.2 | 11.4 | Ch, | 3883.6 | 10.2 | B. |
| | 3857.6 | 11.1 | Ca, | 3892.6 | 11.4 | Ca. |
| | 3866.6 | 11.4 | Lv. | | | |
| 054920b UW ORIONIS— | | | | | | |
| | 3837.6 | 10.9 | Lv, | 3868.6 | 10.5 | Cv. |
| | 3839.6 | 10.7 | Cy, | 3872.6 | 10.6 | Ya, |
| | 3843.6 | 10.7 | Lv, | 3872.6 | 10.5 | Cy, |
| | 3852.6 | 10.3 | Lv, | 3879.6 | 10.7 | Lv, |
| | 3866.6 | 10.5 | Lv. | 3881.6 | 10.5 | Cy. |
| 054974 V CAMELOPARDALIS— | | | | | | |
| | 3852.8 | [15.0 | Pa, | 3886.8 | 15.5 | Pa. |
| 055353 Z AURIGAE— | | | | | | |
| | 3824.1 | 9.8 | Ch, | 3867.6 | 10.9 | B, |
| | 3836.6 | 9.8 | Wf, | 3871.6 | 10.8 | Pt, |
| | 3841.6 | 10.0 | Pt, | 3879.6 | 10.9 | Ya, |
| | 3847.6 | 10.5 | Ya, | 3883.6 | 10.6 | B, |
| | 3848.2 | 10.7 | Ch, | 3883.7 | 10.8 | Wf, |
| | 3848.6 | 10.5 | B, | 3885.5 | 10.8 | Pt. |
| | 3851.2 | 10.7 | Ch, | | | |
| *055686* R OCTANTIS— | | | | | | |
| | 3798.0 | 9.0 | Bl, | 3822.0 | 9.9 | Bl. |
| | 3806.0 | 9.7 | Bl, | 3841.0 | 10.1 | Bl. |
| | 3815.0 | 9.7 | Bl. | | | |
| 060450 X AURIGAE— | | | | | | |
| | 3838.6 | 11.6 | Ie, | 3870.5 | 11.6 | Ie, |
| | 3841.6 | 9.9 | Pt, | 3871.6 | 11.3 | Pt. |
| | 3848.6 | 12.4 | B, | | | |
| 060547 SS AURIGAE— | | | | | | |
| | 3824.1 | [11.6 | Ch, | 3856.5 | 12.5 | Sg, |
| | 3825.2 | [11.4 | Ch, | 3857.4 | [12.4 | L, |
| | 3827.2 | [11.0 | Ch, | 3857.6 | [12.4 | Pt, |
| | 3834.5 | [12.6 | Ie, | 3858.4 | [14.0 | L, |
| | 3834.6 | [12.6 | Br, | 3858.5 | [12.0 | O, |
| | 3835.6 | [13.9 | Wf, | 3858.5 | [12.6 | Ie, |
| | 3836.2 | [12.4 | Ch, | 3858.7 | [10.8 | Cy, |
| | 3836.6 | [13.5 | Wf, | 3858.7 | [13.0 | Br, |
| | 3837.5 | [12.6 | Ie, | 3858.8 | 14.3 | Pa, |
| | 3837.6 | [13.3 | Br, | 3859.3 | [12.4 | L, |
| | 3837.7 | [12.8 | Lv, | 3860.3 | [13.0 | L, |
| | 3838.0 | [12.4 | Ch, | 3860.7 | [13.2 | Sg, |
| | 3838.5 | [13.3 | Ie, | 3861.7 | [11.5 | Pt, |
| | 3839.5 | [13.3 | Ie, | 3864 5 | [12.0 | Pt, |
| | 3839.6 | [11.6 | Cy, | 3867.5 | [13.8 | B. |
| | 3839.7 | [13.4 | Lv, | 3868.1 | [11.4 | Ch, |
| | 3840.2 | [11.0 | Ch, | 3868.6 | [14.4 | Cy, |
| | 3840.8 | [13.0 | Sg, | 3869.1 | [11.6 | Ch, |
| | 3841.1 | [11.6 | Ch, | 3870.5 | [13.3 | Ie, |
| | 3841.6 | [12.6 | Pt, | 3870.7 | [13.3 | Br, |
| | 3841.7 | [13.9 | Lv, | 3871.1 | [11.4 | Ch, |
| | 3842.5 | [12.6 | Pt, | 3871.6 | [12.6 | Kl, |
| | 3842.5 | [13.3 | Ie. | 3871.6 | [12.6 | Pt, |
| | 3842.6 | [13.3 | Y, | 3872.2 | [11.1 | Ch, |
| | 3842.7 | [14.9 | Sg. | 3872.3 | [13.3 | L. |
| | 3843.2 | [11.6 | Ch, | 3872.5 | [12.6 | Ie, |
| | 3843.5 | [12.6 | Pt, | 3872.6 | [12.4 | Cy, |
| | 3843.6 | [13.9 | Lv, | 3872.6 | [12.4 | Ya, |
| | 3844.2 | 12.6 | Ch, | 3872.7 | [13.7 | Lv, |
| | 3844.5 | 11.1 | Cd. | 3873.8 | [12.6 | Sg, |
| | 3844.8 | 10.8 | Sg. | 3874.2 | [11.1 | Ch, |
| | 3845.2 | 10.7 | Ch, | 3874.7 | [14.5 | Sg, |
| | 3845.5 | 10.8 | Ie, | 3875.2 | [11.1 | Ch, |
| | 3845.6 | 11.0 | Br, | 3875.4 | [14.0 | L, |
| | 3845.6 | 10.7 | Cy, | 3875.5 | [13.3 | Ie, |
| | 3846.2 | 10.7 | Ch, | 3875.5 | [11.6 | Cy, |
| | 3846.5 | 10.9 | Cd, | 3876.2 | [11.1 | Ch, |
| | 3846.6 | 10.7 | Ie, | 3876.5 | [13.3 | Ie, |
| | 3846.7 | 10.9 | Ca, | 3876.6 | [11.6 | Cy. |
| | 3846.8 | 10.7 | Pt, | 3877.6 | [13.9 | Lv, |
| | 3847.2 | 10.7 | Ch, | 3877.7 | [15.2 | Sg. |
| | 3847.5 | 10.7 | Ie. | 3878.5 | [13.6 | Ie, |
| | 3847.6 | 10.9 | Ya. | 3878.6 | [13.7 | B. |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 060547 SS AURIGAE—Continued | | | | | | |
| | 3847.7 | 10.8 | Cy, | 3878.6 | [12.6 | Kl, |
| | 3848.2 | 10.7 | Ch, | 3878.7 | [12.6 | Pt, |
| | 3848.5 | 10.7 | Ie, | 3879.5 | [12.4 | Pt, |
| | 3848.5 | 10.6 | Cd; | 3879.5 | [11.6 | Cy, |
| | 3848.5 | 10.8 | Pt, | 3879.6 | [13.3 | Ie, |
| | 3848.6 | 10.9 | Cy, | 3879.7 | [13.3 | Br, |
| | 3848.6 | 11.0 | Y, | 3880.5 | [12.6 | Pt, |
| | 3848.8 | 11.0 | Sg, | 3880.5 | [12.6 | Ie, |
| | 3849.6 | 10.9 | Br, | 3881.5 | [12.6 | Ie, |
| | 3849.6 | 10.7 | B, | 3881.6 | [14.0 | Lv, |
| | 3849.8 | 11.0 | Sg, | 3881.6 | [11.3 | Cy, |
| | 3850.2 | 10.8 | Ch, | 3881.7 | [13.3 | Br, |
| | 3850.5 | 11.0 | Pt, | 3882.5 | [12.6 | Pt, |
| | 3850.6 | 10.9 | Br, | 3882.6 | [13.3 | B, |
| | 3850.7 | 11.0 | Sg, | 3882.7 | [13.3 | Br. |
| | 3851.2 | 10.8 | Ch, | 3883.5 | [12.6 | Pt, |
| | 3851.6 | 11.0 | B, | 3883.6 | 15.2 | Wf, |
| | 3851.7 | 11.0 | Br, | 3883.6 | [12.6 | Kl, |
| | 3852.2 | 10.8 | Ch, | 3883.7 | [13.3 | Br, |
| | 3852.6 | 11.1 | Br, | 3884.5 | [12.6 | Ie, |
| | 3852.6 | 10.9 | Lv, | 3884.6 | [11.6 | Cy, |
| | 3852.8 | 11.4 | Pa, | 3884.7 | 14.9 | Wf, |
| | 3852.8 | 11.2 | Sg, | 3885.5 | [12.6 | Pt, |
| | 3853.1 | 10.9 | Ch, | 3885.6 | [12.6 | Kl, |
| | 3853.5 | 11.5 | Pt, | 3886.5 | [12.6 | Pt, |
| | 3853.6 | 11.1 | B, | 3886.6 | [12.6 | Kl, |
| | 3854.1 | 11.1 | Ch, | 3887.5 | [12.6 | Pt, |
| | 3854.5 | 11.3 | Cd, | 3889.6 | [12.6 | Kl, |
| | 3854.5 | 11.0 | Ie, | 3889.6 | [10.8 | Cy, |
| | 3855.2 | 11.6 | Ch, | 3890.5 | [12.6 | Ie, |
| | 3855.6 | 11.8 | Br, | 3891.5 | [12.6 | Ie, |
| | 3856.2 | 12.0 | Ch, | 3891.6 | [12.6 | Pt, |
| | 3856.7 | 12.4 | Lv, | 3892.6 | [12.5 | B, |
| | 3856.7 | [12.4 | Ca, | 3893.6 | [11.8 | Kl. |
| 061647 V AURIGAE— | | | | | | |
| | 3849.6 | 11.1 | B, | 3883.6 | 11.0 | B. |
| | 3867.6 | 11.0 | B, | | | |
| *061702* V MONOCEROTIS— | | | | | | |
| | 3841.6 | 9.6 | Pt, | 3845.7 | 9.0 | Br, |
| | 3845.1 | 9.2 | Ch, | 3871.6 | 7.2 | Pt, |
| | 3845.6 | 9.1 | Ya, | 3875.6 | 7.5 | Ya. |
| 063159 U LYNCIS— | | | | | | |
| | 3869.6 | 11.9 | B, | 3883.6 | 12.2 | B. |
| 063308 R MONOCEROTIS— | | | | | | |
| | 3841.6 | 10.6 | Pt, | 3871.6 | 10.8 | Pt, |
| | 3869.6 | 11.8 | Ca, | 3878.6 | 11.7 | B. |
| | 3869.6 | 11.6 | B, | | | |
| 063558 S LYNCIS— | | | | | | |
| | 3841.6 | 11.0 | Pt, | 3871.6 | 9.9 | Pt, |
| | 3847.2 | 10.7 | Ch, | 3879.6 | 10.5 | Ya, |
| | 3849.7 | 10.7 | Ya, | 3883.6 | 10.2 | B. |
| | 3869.6 | 10.3 | B, | | | |
| 064030 X GEMINORUM— | | | | | | |
| | 3849.7 | 13.5 | Br, | 3873.7 | 13.5 | B. |
| *064707* W MONOCEROTIS— | | | | | | |
| | 3841.6 | 10.8 | Pt, | 3871.6 | 11.0 | Pt, |
| | 3845.6 | 10.8 | Ya, | 3874.6 | 10.9 | B, |
| | 3849.7 | 11.0 | Br, | 3875.6 | 11.4 | Ya. |

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 065111 Y MONOCEROTIS— | | | | | | |
| | 3837.6 | 10.7 | Lv, | 3852.7 | 12.0 | Lv, |
| | 3839.6 | 10.8 | Y, | 3863.6 | 12.1 | Lv, |
| | 3841.6 | 10.7 | Pt, | 3871.6 | 12.2 | Pt, |
| | 3841.7 | 11.1 | Lv, | 3872.6 | 13.4 | Lv, |
| | 3845.2 | 11.6 | Ch, | 3874.6 | 13.3 | B, |
| | 3845.6 | 11.0 | Ya, | 3881.6 | 13.5 | Lv. |
| *065208* X MONOCEROTIS— | | | | | | |
| | 3839.6 | 8.4 | Ca, | 3858.4 | 8.2 | L, |
| | 3845.2 | 8.4 | Ch, | 3867.5 | 8.1 | Ca, |
| | 3845.6 | 8.5 | Ya, | 3875.6 | 8.0 | Ya. |
| | 3857.5 | 8.5 | Ca, | | | |
| 065355 R LYNCIS— | | | | | | |
| | 3846.6 | 12.5 | Ie, | 3869.6 | 10.9 | Ie, |
| | 3849.7 | 12.6 | Br, | 3879.6 | 10.4 | Ya. |
| 070122a R GEMINORUM— | | | | | | |
| | 3837.6 | 9.5 | Lv, | 3856.6 | 9.9 | Ca, |
| | 3838.6 | 9.4 | Ie, | 3858.6 | 10.0 | Ya, |
| | 3840.8 | 9.0 | Ya, | 3863.7 | 10.2 | Pa, |
| | 3841.6 | 9.4 | Pt, | 3866.6 | 10.3 | Lv, |
| | 3841.7 | 9.5 | Ca, | 3867.6 | 9.9 | Ca, |
| | 3843.6 | 9.4 | Al, | 3869.6 | 9.9 | B, |
| | 3843.6 | 9.5 | Lv, | 3871.6 | 10.4 | Pt, |
| | 3846.7 | 9.4 | Pa, | 3873.8 | 11.0 | Sg. |
| | 3847.0 | 9.6 | Al, | 3876.6 | 10.6 | Ie, |
| | 3850.7 | 9.5 | Pa, | 3878.6 | 10.1 | B, |
| | 3850.7 | 9.5 | Br, | 3879.6 | 10.8 | Ca, |
| | 3852.7 | 10.0 | Lv, | 3879.6 | 10.8 | Lv, |
| | 3852.8 | 10.0 | Sg, | 3879.7 | 10.9 | Pa, |
| | 3854.6 | 10.0 | Ie, | 3892.6 | 10.0 | B. |
| 070122b Z GEMINORUM— | | | | | | |
| | 3837.6 | 12.4 | Lv, | 3869.6 | 12.4 | B, |
| | 3838.6 | 12.3 | Ie, | 3871.6 | 12.4 | Pt, |
| | 3841.6 | 12.5 | Pt, | 3876.6 | 12.3 | Ie, |
| | 3843.6 | 12.4 | Lv, | 3878.6 | 12.6 | B, |
| | 3866.6 | 12.4 | Lv, | 3879.6 | 12.6 | Lv. |
| 070122c TW GEMINORUM— | | | | | | |
| | 3837.6 | 8.4 | Lv | 3867.6 | 7.9 | Ca, |
| | 3841.6 | 7.7 | Pt, | 3869.6 | 8.1 | B, |
| | 3841.7 | 8.3 | Ca, | 3871.6 | 7.7 | Pt, |
| | 3843.6 | 8.5 | Lv, | 3878.6 | 8.2 | B, |
| | 3847.0 | 8.0 | Al, | 3879.6 | 8.4 | Lv, |
| | 3852.7 | 8.4 | Lv, | 3879.6 | 8.4 | Ca, |
| | 3856.6 | 8.3 | Ca. | 3892.6 | 8.4 | B. |
| | 3866.6 | 8.3 | Lv, | | | |
| 070310 R CANIS MINORIS— | | | | | | |
| | 3853.6 | 8.9 | B, | 3874.6 | 9.2 | B, |
| | 3858.4 | 9.0 | L, | 3881.5 | 9.8 | Ya. |
| | 3870.6 | 9.2 | Ca, | | | |
| 071713 V GEMINORUM— | | | | | | |
| | 3841.6 | 13.2 | Pt, | 3850.7 | 13.5 | Br. |
| 072708 S CANIS MINORIS— | | | | | | |
| | 3837.5 | 9.2 | Cd, | 3871.6 | 7.9 | Pt, |
| | 3838.1 | 9.5 | Ch, | 3872.6 | 8.0 | Ya, |
| | 3839.6 | 9.2 | Cy, | 3872.6 | 8.1 | Js, |
| | 3840.7 | 9.5 | Sg, | 3872.6 | 8.0 | Hr, |
| | 3841.6 | 9.1 | Pt, | 3872.6 | 8.0 | Cy. |
| | 3854.3 | 9.1 | Ch, | 3872.6 | 7.9 | Ca, |
| | 3847.6 | 9.0 | Ie, | 3873.8 | 7.5 | Sg, |
| | 3850.7 | 8.6 | Br, | 3874.2 | 8.0 | Ch, |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 072708 S CANIS MINORIS—Continued | | | | | | |
| | 3852 8 | 8.7 | Sg, | 3874.6 | 7.7 | B, |
| | 3853.6 | 9.0 | B, | 3879.5 | 7.6 | Ca, |
| | 3858.4 | 8.6 | L, | 3879.6 | 7.7 | Al, |
| | 3858.7 | 8.7 | Cy, | 3881.5 | 7.5 | Ya, |
| | 3861.6 | 8.5 | M, | 3881.6 | 7.9 | Cy, |
| | 3865.5 | 8.3 | Ca, | 3892.6 | 7.3 | Ca, |
| | 3868.6 | 7.7 | Ie, | 3882.6 | 7.8 | Lf, |
| | 3868.6 | 8.2 | Cy, | 3886.6 | 7.4 | Ca, |
| | 3870.6 | 7.9 | Lf, | 3889.7 | 7.5 | Cy. |
| 072811 T CANIS MINORIS— | | | | | | |
| | 3748.6 | 13.8 | B, | 3873.6 | 13.6 | B. |
| *072830b* Z PUPPIS— | | | | | | |
| | 3850.7 | 11.0 | Br. | | | |
| *073173* S VOLANTIS— | | | | | | |
| | 3798 0 | 9.1 | Bl, | 3815.0 | 9.8 | Bl. |
| | 3806.0 | 9.3 | Bl, | | | |
| 073508 U CANIS MINORIS— | | | | | | |
| | 3839.6 | 8.9 | Y, | 3858.4 | 9.0 | L, |
| | 3842.5 | 8.8 | Pt, | 3871.6 | 9.1 | Pt, |
| | 3852.7 | 9.1 | Br, | 3874.7 | 9.1 | B. |
| 073723 S GEMINORUM— | | | | | | |
| | 3852.7 | 14.0 | Br, | 3873.7 | 13.7 | B. |
| *074241* W PUPPIS— | | | | | | |
| | 3799.1 | 10.5 | Bl, | 3815.0 | 12.2 | Bl, |
| | 3806 0 | 11.0 | Bl, | 3841.0 | 11.0 | Pl. |
| 074323 T GEMINORUM— | | | | | | |
| | 3873.7 | 12.3 | B. | | | |
| 074922 U GEMINORUM— | | | | | | |
| | 3822.0 | 9.5 | Ch, | 3864.5 | [10.8 | Pt, |
| | 3824.1 | 8.9 | Ch, | 3866.6 | [13.7 | Lv, |
| | 3825.1 | 8.9 | Ch, | 3867.6 | [13.7 | Ie, |
| | 3826.1 | 8.9 | Ch, | 3868.1 | [11.7 | Ch, |
| | 3828.1 | 9.0 | Ch, | 3868.6 | [11.7 | Cy, |
| | 3829.1 | 9.2 | Ch, | 3869.1 | [12.3 | Ch, |
| | 3830.1 | 9.6 | Ch, | 3869.6 | 14.0 | B, |
| | 3831.0 | 9.8 | Ch, | 3869.6 | [13.3 | Ie, |
| | 3832.7 | 10.1 | Hr, | 3870.1 | [12.3 | Ch, |
| | 3834.5 | [10.9 | Ie, | 3870.7 | [13.3 | Br, |
| | 3835.1 | [10.3 | Ch, | 3871.1 | [12.3 | Ch, |
| | 3835.6 | 12.6 | Wf | 3871.6 | [12.4 | Pt, |
| | 3836.2 | [12.3 | Ch, | 3871.6 | [13.0 | Kl, |
| | 3836.5 | 13.5 | Wf, | 3872.2 | [11.4 | Ch, |
| | 3837.5 | 13.6 | Cd, | 3872.3 | 13.7 | L, |
| | 3837.7 | [12.7 | Lv, | 3872.5 | [13.3 | Ie, |
| | 3838.0 | [12.4 | Ca, | 3872.6 | [11.7 | Cy, |
| | 3838.5 | [13.3 | Ie, | 3873.6 | 14.0 | B, |
| | 3838.5 | 13.6 | Cd, | 3874.2 | [11.7 | Ch, |
| | 3838.5 | [13.7 | B, | 3874.6 | [13.3 | B, |
| | 3839.5 | 13.7 | Cd, | 3875.2 | [11.7 | Ca, |
| | 3839.6 | [13.3 | Y, | 3875.4 | [13.7 | L, |
| | 3839.6 | [13.7 | Ie. | 3875.5 | [13.7 | Ie, |
| | 3839.6 | [12.4 | Cy, | 3875.5 | [11.7 | Cy, |
| | 3839.6 | 13.9 | Lv, | 3876.2 | [11.4 | Ch, |
| | 3841.6 | [13.3 | Pt, | 3876.5 | [13.3 | Ie, |
| | 3841.7 | 14.0 | Lv, | 3876.6 | [11.4 | Cy, |
| | 3841.7 | [12.4 | Ca, | 3878.5 | [12.6 | Ie, |
| | 3842.5 | 13.8 | Cd, | 3878.6 | [13.7 | Lv, |
| | 3842.5 | [13.3 | Pt, | 3878.6 | [13.8 | B, |
| 074922 U GEMINORUM—Continued | | | | | | |
| | 3843.0 | [12.4 | Ch, | 3878.7 | [12.4 | Pt, |
| | 3843.5 | [13.3 | Pt, | 3879.5 | [11.3 | Pt, |
| | 3845.0 | [12.4 | Ch, | 3879.6 | [12.4 | Ca, |
| | 3845.6 | [11.7 | Cy, | 3879.6 | [13.3 | Ie, |
| | 3846.6 | 13.8 | Cd, | 3879.7 | [13.7 | Br, |
| | 3846.8 | [13.3 | Pt, | 3880.5 | [12.6 | Ie, |
| | 3847.0 | [12.4 | Ch, | 3880.5 | [12.3 | Pt, |
| | 3847.7 | [10.9 | Cy, | 3880.5 | [11.4 | Cy, |
| | 3848.5 | [13.3 | Pt, | 3881.5 | [13.3 | Ie, |
| | 3848.5 | [13.8 | B, | 3881.6 | [11.4 | Cy, |
| | 3848.6 | [13.3 | Y, | 3881.7 | [13.3 | Br, |
| | 3849.6 | [13.3 | Br, | 3882.5 | [12.0 | Pt, |
| | 3850.1 | [12.3 | Ch, | 3882.6 | [13.7 | B, |
| | 3850.5 | [12.4 | Pt, | 3882.7 | [13.3 | Br, |
| | 3850.6 | [13.3 | Br, | 3883.6 | [12.6 | Kl, |
| | 3851.2 | [12.4 | Ch, | 3883.7 | [13.3 | Br, |
| | 3851.6 | [13.7 | B, | 3883.7 | 14.0 | Wf, |
| | 3852.2 | [12.3 | Ch. | 3883.8 | [12.4 | Pt, |
| | 3852.6 | [13.3 | Br, | 3884.5 | [13.3 | Ie, |
| | 3853.2 | [12.3 | Ch, | 3884.6 | [11.4 | Cy, |
| | 3853.5 | [13.3 | Pt, | 3884.7 | 13.9 | Wf, |
| | 3854.2 | [12.3 | Ch. | 3885.5 | [12.4 | Pt, |
| | 3855.2 | [11.7 | Ch, | 3885.6 | [12.3 | Kl, |
| | 3855.7 | [13.7 | Br, | 3886.5 | [12.0 | Pt, |
| | 3856.2 | [11.7 | Ch, | 3886.6 | [12.3 | Kl, |
| | 3856.7 | [12.4 | Ca, | 3886.6 | [13.3 | Lv, |
| | 3857.4 | 14.0 | L. | 3889.6 | [9.3 | Cy, |
| | 3857.6 | [12.3 | Pt, | 3889.7 | [11.4 | Kl, |
| | 3858.5 | [11.8 | Pt, | 3890.6 | [12 4 | Ie, |
| | 3858.7 | [10.9 | Cy. | 3891.6 | [10.0 | Pt, |
| | 3861.7 | [10.5 | Pt, | 3892.6 | [13.3 | B. |
| *075612* U PUPPIS— | | | | | | |
| | 3852.8 | 10.7 | Pa, | 3869.6 | 12.1 | B. |
| 081112 R CANCRI— | | | | | | |
| | 3829.1 | 8.6 | Ch, | 3867.6 | 6.4 | Ly, |
| | 3839.6 | 7.9 | Ie, | 3868.6 | 7.3 | Cy, |
| | 3840.1 | 7.6 | Ch, | 3871.2 | 6.6 | Ch, |
| | 3840.6 | 8.4 | Kl, | 3871.6 | 6.3 | Pt, |
| | 3842.5 | 7.5 | Pt. | 3873.6 | 6.1 | Ly, |
| | 3843.6 | 7.7 | Ly, | 3873.6 | 6.6 | Ca, |
| | 3847.1 | 7.3 | Ch, | 3875.7 | 6.9 | Cy, |
| | 3849.6 | 7.4 | Kl, | 3876.6 | 6.2 | Ly, |
| | 3851.6 | 7.1 | Ly, | 3881.6 | 6.8 | Ya, |
| | 3853.6 | 7.0 | B, | 3883.7 | 6.8 | Kl, |
| | 3854.6 | 7.0 | Ie, | 3886 6 | 6.1 | Ly, |
| | 3855.1 | 6.8 | Ch, | 3886.6 | 6.8 | Ca, |
| | 3857.6 | 6.8 | Ly, | 3892.6 | 6.5 | B. |
| | 3858.4 | 6.5 | L, | | | |
| 081617 V CANCRI— | | | | | | |
| | 3829.1 | 9.8 | Ch. | 3855.8 | 8.8 | Ch, |
| | 3840.1 | 9.2 | Ch, | 3868 6 | 8.0 | Cy, |
| | 3842.5 | 9.0 | Pt, | 3871.6 | 7.6 | Pt. |
| | 3850.1 | 8.8 | Ch, | 3875.7 | 7.9 | Cy, |
| | 3851.6 | 8 7 | B, | 3883.7 | 8.2 | Pt, |
| | 3852.7 | 8.8 | Br, | 3884.7 | 8.4 | Pt. |
| *082405* RT HYDRAE— | | | | | | |
| | 3842.5 | 8.2 | Pt, | 3859.3 | 7.8 | L, |
| | 3853.6 | 8.3 | B, | 3871.6 | 7.5 | Pt. |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 083019 U CANCRI— | | | | | | |
| | 3839.6 | 10.8 | Ie, | 3868.6 | 10.1 | Ie, |
| | 3839.7 | 9.4 | Lv, | 3872.7 | 10.2 | Lv, |
| | 3841.7 | 10.2 | Pa, | 3877.7 | 10.2 | Lv, |
| | 3852.7 | 9.8 | Br, | 3879.6 | 10.3 | Lv, |
| | 3856.7 | 9.5 | Lv, | 3883.7 | 10.2 | Wf, |
| | 3863.6 | 9.9 | Lv, | 3886.7 | 10.8 | Lv. |
| 083350 X URSAE MAJORIS— | | | | | | |
| | 3842.5 | 12.4 | Pt, | 3844.6 | 12.3 | B. |
| 084803 S HYDRAE— | | | | | | |
| | 3842.5 | 11.7 | Pt, | 3855.7 | 10.8 | Br, |
| | 3844.6 | 11.1 | B, | 3871.2 | 10.3 | Ch, |
| | 3850.1 | 10.8 | Ch, | 3871.6 | 10.0 | Pt, |
| | 3855.1 | 10.5 | Ch, | 3878.6 | 10.3 | B. |
| *085008* T HYDRAE— | | | | | | |
| | 3829.1 | 9.9 | Ch, | 3859.3 | 11.4 | L, |
| | 3843.5 | 10.6 | Pt, | 3871.6 | 11.7 | Pt, |
| | 3851.6 | 10.9 | B, | 3878.6 | 11.8 | B. |
| | 3855.7 | 11.5 | Br, | | | |
| 085120 T CANCRI— | | | | | | |
| | 3840.1 | 9.0 | Ch, | 3871.6 | 8.1 | Pt, |
| | 3843.5 | 8.1 | Pt, | 3874.3 | 9.7 | Ch. |
| | 3859.4 | 8.1 | L, | | | |
| 090151 V URSAE MAJORIS— | | | | | | |
| | 3848.6 | 9.9 | B, | 3878.5 | 10.2 | B. |
| 090425 W CANCRI— | | | | | | |
| | 3855.7 | 9.3 | Br, | 3876.7 | 10.0 | Cy, |
| | 3859.4 | 9.1 | L, | 3883.7 | 10.0 | Wf. |
| *092551* Y VELORUM— | | | | | | |
| | 3799.1 | 13.5 | Bl, | 3822.0 | 13.5 | Bl. |
| | 3815.0 | 13.2 | Bl, | | | |
| *092962* R CARINAE— | | | | | | |
| | 3799.1 | 4.1 | Bl, | 3822.0 | 4.9 | Bl, |
| | 3806.0 | 4.5 | Bl, | 3841.0 | 5.6 | Bl. |
| | 3815.0 | 4.3 | Bl, | | | |
| *093014* X HYDRAE— | | | | | | |
| | 3843.5 | 11.3 | Pt, | 3871.6 | 10.8 | Pt, |
| | 3844.6 | 11.7 | Pt, | 3874.2 | 11.0 | Ch, |
| | 3855.7 | 11.2 | Br, | 3878.6 | 11.1 | B. |
| | 3870.7 | 11.1 | Br, | | | |
| 093934 R LEONIS— | | | | | | |
| | 3825.2 | 9.5 | Ch, | 3858.7 | 6.9 | Pa, |
| | 3829.1 | 9.2 | Ch, | 3859.4 | 6.5 | L, |
| | 3838.1 | 8.5 | Ch, | 3861.7 | 7.0 | M, |
| | 3841.1 | 8.3 | Ch, | 3864.1 | 6.5 | Ch, |
| | 3843.1 | 8.0 | Ch, | 3870.7 | 7.0 | Br, |
| | 3843.5 | 7.7 | Pt, | 3871.6 | 6.9 | Pt, |
| | 3847.1 | 7.7 | Ch, | 3872.2 | 6.8 | Ch, |
| | 3849.6 | 7.6 | Kl, | 3874.2 | 7.0 | Ch, |
| | 3850.1 | 7.4 | Ch, | 3874.6 | 6.8 | B, |
| | 3851.6 | 7.4 | B, | 3876.7 | 7.4 | Cy, |
| | 3857.6 | 6.8 | Pt, | 3878.6 | 6.6 | Al. |
| | 3858.0 | 7.0 | Ch, | | | |
| 094211 R LEONIS— | | | | | | |
| | 3825.2 | 10.4 | Ch, | 3858.7 | 9.2 | Cy, |
| | 3832.7 | 10.1 | Hr, | 3858.9 | 10.0 | Hm, |
| | 3839.6 | 10.3 | Ly, | 3860.7 | 8.5 | Sg, |
| | 3839 7 | 9.8 | Hr, | 3861.7 | 9.3 | M, |
| | 3839.7 | 9.9 | Cy, | 3865.5 | 9.3 | Ca, |
| | 3842.6 | 9.9 | Ca, | 3867.3 | 9.6 | Ch, |
| | 3842.7 | 9.8 | Al, | 3867.6 | 9.9 | Ly, |

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 094211 R LEONIS—Continued | | | | | | |
| | 3843.5 | 9.1 | Pt, | 3868.6 | 9.0 | Cy, |
| | 3843.7 | 9.4 | Sg, | 3871.6 | 8.7 | Pt, |
| | 3845.6 | 9.0 | Js, | 3872.6 | 9.4 | Js, |
| | 3847.1 | 10.2 | Ch, | 3873.6 | 9.6 | Ly, |
| | 3847.6 | 9.6 | Cy, | 3874.2 | 9.1 | Ch, |
| | 3848.6 | 10.4 | Mh, | 3875.5 | 9.3 | Cy, |
| | 3848.6 | 10.2 | Ly, | 3878.6 | 9.0 | Al. |
| | 3850.1 | 10.2 | Ch, | 3878.6 | 8.7 | B, |
| | 3851.6 | 9.0 | B, | 3880.5 | 9.5 | Ly, |
| | 3851.6 | 10.1 | Ly, | 3881.6 | 9.2 | Cy, |
| | 3857.5 | 9.5 | Ca, | 3881.8 | 8.9 | Sg, |
| | 3857.6 | 9.9 | Ly, | 3886.5 | 9 3 | Ly, |
| | 3857.6 | 9.2 | Pt, | 3886.6 | 8.7 | Ca, |
| | 3858.0 | 9.9 | Ch, | 3895.6 | 8.7 | Al. |
| *094622* Y HYDRAE— | | | | | | |
| | 3843.5 | 6.5 | Pt, | 3871.6 | 6.4 | Pt. |
| *094953* Z VELORUM— | | | | | | |
| | 3799.1 | 11.0 | Bl, | 3822.0 | 11.9 | Bl, |
| | 3806.0 | 11.5 | Bl, | 3842.0 | 12.5 | Bl. |
| | 3815.1 | 11.5 | Bl, | | | |
| 095421 V LEONIS— | | | | | | |
| | 3839.7 | 9.4 | Lv, | 3868.7 | 9.3 | Cy, |
| | 3840.7 | 9.6 | Sg, | 3871.6 | 9.6 | Pt, |
| | 3843.5 | 9.4 | Pt, | 3872.6 | 9.6 | B, |
| | 3846.6 | 9.2 | B, | 3872.7 | 9.9 | Lv, |
| | 3850.1 | 9.2 | Ch, | 3875.7 | 9.6 | Cy, |
| | 3853.8 | 9.5 | Sg, | 3877.7 | 10.2 | Lv, |
| | 3856.7 | 9.5 | Lv, | 3881.6 | 9.7 | Cy, |
| | 3858.1 | 9.3 | Ch, | 3883.7 | 10.4 | Wf, |
| | 3861.7 | 9.6 | M, | 3886.7 | 10.4 | Lv, |
| | 3868.7 | 9.7 | Sg, | 3889.7 | 10.2 | Cy. |
| *100661* S CARINAE— | | | | | | |
| | 3799.1 | 7.3 | Bl, | 3826.0 | 6.1 | Bl, |
| | 3806.0 | 6.8 | Bl, | 3842.0 | 5.5 | Bl. |
| | 3815.1 | 6.3 | Bl, | | | |
| *101153* W VELORUM— | | | | | | |
| | 3799.1 | 11.3 | Bl, | 3826.0 | 11.7 | Bl, |
| | 3806.0 | 11.4 | Bl, | 3842.0 | 12.1 | Bl. |
| | 3815.1 | 11.6 | Bl, | | | |
| *103212* U HYDRAE— | | | | | | |
| | 3812.1 | 5.9 | Kd, | 3840.0 | 6.1 | Kd, |
| | 3819.0 | 6.0 | Kd, | 3856.2 | 6.0 | Kd, |
| | 3824.1 | 6.0 | Kd, | 3859.1 | 6.1 | Kd, |
| | 3836.2 | 6.0 | Kd, | 3873.1 | 6.1 | Kd. |
| 103769 R URSAE MAJORIS— | | | | | | |
| | 3822.2 | 10.8 | Ch, | 3858.5 | 7.4 | Ly, |
| | 3827.2 | 9.9 | Ch, | 3858.7 | 7.5 | Br, |
| | 3829.1 | 9.7 | Ch, | 3858.8 | 7.6 | Cy, |
| | 3835.1 | 8.8 | Ch, | 3860.5 | 7.2 | Ly, |
| | 3837.5 | 8.7 | Ly, | 3860.8 | 6.5 | M, |
| | 3837.8 | 8.3 | Sg, | 3865.5 | 7.3 | Ly, |
| | 3838.6 | 8.7 | Ie, | 3865.5 | 7.0 | Ca, |
| | 3839.5 | 8.4 | Ly, | 3868.6 | 6.9 | Cy, |
| | 3839.6 | 8.1 | Cd, | 3869.1 | 7.0 | Ch, |
| | 3840.5 | 8.4 | Ca, | 3871.6 | 7.0 | Kl, |
| | 3840.6 | 8.1 | Kl, | 3871.6 | 6.5 | Pt, |
| | 3841.1 | 8.4 | Ch, | 3872.6 | 8.6 | Cy, |
| | 3843.5 | 7.9 | Pt, | 3872.6 | 6.8 | B, |
| | 3843.6 | 8.0 | Ly, | 3873.6 | 7.5 | Al, |
| | 3844.7 | 8.2 | Al, | 3874.2 | 6.8 | Ch, |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est.Obs. | J.D. | Est.Obs. |
|---|---|---|---|---|
| 103769 R URSAE MAJORIS—Continued | | | | |
| | 3846.5 | 7.9 Ca, | 3876.5 | 6.5 Ly, |
| | 3847.1 | 8.0 Ch, | 3879.5 | 7.0 Ie, |
| | 3847.6 | 8.0 Kl, | 3879.6 | 7.5 Al, |
| | 3848.6 | 7.9 Ly, | 3882.7 | 7.5 Sg, |
| | 3848.6 | 8.1 Mh, | 3884.7 | 7.5 Cy, |
| | 3849.7 | 7.8 Sg, | 3884.7 | 7.5 Hr, |
| | 3850.1 | 7.9 Ch, | 3886.5 | 7.2 Ly, |
| | 3853.6 | 7.7 B, | 3886.5 | 7.2 Ca, |
| | 3854.6 | 7.7 Ie, | 3891.5 | 7.6 Ca, |
| | 3856.6 | 7.4 Ca, | 3892.6 | 7.7 Ly, |
| | 3857.2 | 7.8 Ch. | 3895.6 | 7.6 Al. |
| *104620* V HYDRAE— | | | | |
| | 3799.1 | 9.4 Bl, | 3843.5 | 8.7 Pt, |
| | 3806.0 | 8.7 Bl, | 3844.1 | 9.5 Ch, |
| | 3815.1 | 9.1 Bl, | 3842.2 | 9.6 Ch, |
| | 3822.2 | 9.6 Ch, | 3854.2 | 9.8 Ch, |
| | 3825.2 | 9.5 Ch, | 3859.4 | 8.9 L, |
| | 3826.0 | 9.4 Bl, | 3869.1 | 9.9 Ch, |
| | 3833.6 | 9.4 Ch, | 3871.6 | 8.9 Pt. |
| | 3840.1 | 9.5 Ch, | 3876.2 | 10.0 Ch. |
| | 3842.0 | 8.7 Bl, | | |
| *104928* RS HYDRAE— | | | | |
| | 3799.1 | 14.0 Bl. | | |
| 104814 W LEONIS— | | | | |
| | 3841.7 | 11.4 Pa, | 3871.6 | 10.5 Pt, |
| | 3849.6 | 10.5 B, | 3872.7 | 10.8 Lv, |
| | 3850.8 | 10.6 Pa, | 3879.7 | 10.7 Br, |
| | 3855.2 | 10.8 Ch, | 3881.7 | 11.1 Lv. |
| | 3861.8 | 10.5 M, | | |
| 110506 S LEONIS— | | | | |
| | 3843.2 | 11.7 Ch, | 3855.2 | 11.2 Ch, |
| | 3843.5 | 11.8 Pt, | 3869.6 | 10.1 Ie, |
| | 3845.6 | 11.6 Ie, | 3871.6 | 10.1 Pt. |
| | 3849.6 | 10.6 B, | | |
| *111661* RS CENTAURI— | | | | |
| | 3799.1 | 13.1 Bl, | 3826.0 | 13.6 Bl, |
| | 3815.1 | 13.6 Bl, | 3842.0 | 10.5 Bl. |
| *114441* X CENTAURI— | | | | |
| | 3799.1 | 11.2 Bl, | 3826.0 | 12.2 Bl, |
| | 3806.0 | 11.2 Bl, | 3842.0 | 12.6 Bl. |
| | 3815.1 | 11.9 Bl, | | |
| *115058* W CENTAURI— | | | | |
| | 3799.1 | 11.8 Bl, | 3826.0 | 9.4 Bl, |
| | 3806.0 | 11.0 Bl, | 3842.0 | 8.2 Bl. |
| | 3815.1 | 10.3 Bl, | | |
| 115919 R COMAE BERENICES— | | | | |
| | 3873.7 | 13.0 Lv, | 3879.7 | 13.2 Br, |
| | 3876.6 | 13.0 Ie, | 3883.8 | 12.7 Wf, |
| | 3877.7 | 13.0 Sg, | 3884.6 | 12.2 B. |
| | 3879.7 | 13.1 Lv, | | |
| 120012 SU VIRGINIS— | | | | |
| | 3877.6 | 12.3 B, | 3881.8 | 12.1 Br. |
| *120905* T VIRGINIS— | | | | |
| | 3851.8 | 14.9 Pa, | 3879.7 | 13.0 Lv, |
| | 3864.8 | 14.3 Pa, | 3886.7 | 12.9 Lv, |
| *121418* R CORVI— | | | | |
| | 3846.8 | 9.8 Pt, | 3871.6 | 10.9 Pt, |
| | 3860.7 | 10.7 L, | 3877.6 | 11.2 B. |

| Star | J.D. | Est.Obs. | J.D. | Est.Obs. |
|---|---|---|---|---|
| 122001 SS VIRGINIS— | | | | |
| | 3814.1 | 8.3 Kd, | 3859.4 | 8.1 L, |
| | 3824.1 | 8.6 Kd, | 3877.6 | 8.5 B. |
| | 3836.2 | 8.6 Kd, | | |
| 122532 T CANUM VENATICORUM— | | | | |
| | 3843.5 | 9.2 Pt, | 3874 6 | 10.2 B, |
| | 3861.6 | 10.1 M, | 3879.7 | 10.2 Br, |
| | 3871.7 | 9.5 Pt, | 3886.8 | 9.8 M. |
| *122803* Y VIRGINIS— | | | | |
| | 3851.8 | 14.3 Pa, | 3864.8 | 14.0 Pa. |
| *122854* U CENTAURI— | | | | |
| | 3799.1 | 12.0 Bl, | 3826.0 | 10.8 Bl, |
| | 3806.0 | 11.7 Bl, | 3842.0 | 10.3 Bl. |
| | 3815.1 | 11.6 Bl, | | |
| 123160 T URSAE MAJORIS— | | | | |
| | 3832.7 | 6.9 Hr, | 3858.7 | 7.7 Br, |
| | 3837.5 | 6.9 Ly, | 3860.6 | 7.5 Ly, |
| | 3837.8 | 6.8 Sg, | 3860.8 | 7.4 M, |
| | 3838.6 | 7.0 Ie, | 3865.5 | 8.1 Ca, |
| | 3838.6 | 6.9 Ca, | 3867.5 | 8.1 Ly, |
| | 3839.7 | 6.8 Ly, | 3868.6 | 8.2 Cy, |
| | 3839.7 | 6.8 Hr, | 3871.6 | 8.1 Kl, |
| | 3840.6 | 7.1 Kl, | 3872.5 | 8.6 Ca, |
| | 3842.5 | 6.9 Cd, | 3872.6 | 8.5 Cy, |
| | 3843.5 | 7.1 Ca, | 3872.6 | 8.5 B, |
| | 3843.5 | 7.3 Pt, | 3873.5 | 8.4 Ly, |
| | 3843.6 | 6.9 Ly, | 3873.7 | 8.3 Al, |
| | 3843.7 | 6.8 Cy, | 3874.8 | 8.4 Sg, |
| | 3844.7 | 7.8 Al, | 3875.6 | 8.6 Cy, |
| | 3847.6 | 7.4 Kl, | 3878.7 | 8.5 Pt, |
| | 3847.6 | 8.0 Al, | 3879.5 | 8.5 Ie, |
| | 3847.7 | 6.7 Cy, | 3879.7 | 8.8 Al, |
| | 3848.6 | 7.0 Ly, | 3884.7 | 9.3 Cy, |
| | 3849.7 | 7.6 Sg, | 3884.7 | 9.9 Hr, |
| | 3851.6 | 6.9 Ly, | 3886.5 | 9.6 Ly, |
| | 3852.7 | 7.1 Cy, | 3890.7 | 9.0 Al, |
| | 3854.6 | 7.4 Ie, | 3890.8 | 9.4 M, |
| | 3856.6 | 7.7 Ca, | 3891.5 | 9.1 Ca, |
| | 3857.6 | 7.0 Ly, | 3892.6 | 9.2 Ly, |
| | 3858.5 | 7.3 Ly, | 3895.6 | 9.4 Al. |
| | 3858.7 | 7.9 Cy, | | |
| 123307 R VIRGINIS— | | | | |
| | 3846.7 | 10.2 Ca, | 3877.6 | 11.5 B, |
| | 3857.6 | 10.9 Ca, | 3878.7 | 11.5 Pt, |
| | 3860.7 | 11.4 L, | 3886.6 | 10.9 Ca. |
| 123459 RS URSAE MAJORIS— | | | | |
| | 3842.5 | 13.8 Cd, | 3873.7 | 14.0 Sg, |
| | 3843.5 | 13.6 Pt, | 3878 7 | 14.0 Pt, |
| | 3850.7 | 14.0 Sg, | 3883.6 | 14.1 Wf. |
| 123961 S URSAE MAJORIS— | | | | |
| | 3832.7 | 8.4 Hr, | 3860.8 | 8.8 M, |
| | 3837.5 | 8.3 Ly, | 3861.3 | 8.2 L, |
| | 3837.8 | 7.8 Sg, | 3864.9 | 8.8 Cy, |
| | 3838.6 | 8.2 Ca, | 3865.5 | 9.1 Ly, |
| | 3839.7 | 8.4 Cy, | 3865.5 | 9.1 Ca, |
| | 3839.7 | 8.5 Hr, | 3871.6 | 9.3 Kl, |
| | 3842.5 | 8.7 Cd, | 3873.5 | 9.3 Ly, |
| | 3843.5 | 8.0 Pt, | 3873.7 | 8.5 Al, |
| | 3843.5 | 8.4 Ca, | 3874.6 | 8.9 B, |
| | 3843.6 | 8.4 Cy, | 3874.8 | 9.2 Sg, |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 123961 S URSAE MAJORIS—Continued | | | | | | |
| | 3844.7 | 7.8 | Al, | 3875.7 | 9.1 | Cy, |
| | 3847.6 | 8.0 | Al, | 3878.7 | 9.4 | Pt, |
| | 3847.7 | 8.5 | Cy, | 3879.5 | 9.4 | Ca, |
| | 3848.6 | 8.5 | Ly, | 3879.7 | 8.8 | Al, |
| | 3849.6 | 8.5 | Kl, | 3884.7 | 9.8 | Cy, |
| | 3849.7 | 8.2 | Sg, | 3884.7 | 9.9 | Hr, |
| | 3853.6 | 8.0 | B, | 3886.5 | 9.6 | Ly, |
| | 3856.5 | 8.6 | Ca, | 3890.7 | 9.7 | Al, |
| | 3857.5 | 8.6 | Ly, | 3890.8 | 10.0 | M, |
| | 3858.7 | 8.9 | Br, | 3891.5 | 9.7 | Ca, |
| | 3858.7 | 8.7 | Cy, | 3892.6 | 9.7 | Ly, |
| | 3860.5 | 8.7 | Ly, | 3895.6 | 10.0 | Al. |
| 124204 RU VIRGINIS— | | | | | | |
| | 3846.8 | 12.0 | Pt, | 3878.7 | 11.8 | Pt. |
| | 3873.7 | 12.1 | B, | | | |
| 134606 U VIRGINIS— | | | | | | |
| | 3846.8 | 8.7 | Pt, | 3882.6 | 8.4 | B. |
| | 3878.7 | 8.2 | Pt, | | | |
| *130212* RV VIRGINIS— | | | | | | |
| | 3878.7 | 13.2 | B, | 3883.7 | 13.2 | B. |
| *131283* U OCTANTIS— | | | | | | |
| | 3799.1 | 10.8 | Bl, | 3826.0 | 11.8 | Bl, |
| | 3806.0 | 11.0 | Bl, | 3842.0 | 12.8 | Bl. |
| | 3815.1 | 11.2 | Bl, | | | |
| *132002* W VIRGINIS— | | | | | | |
| | 3878.7 | 9.5 | B. | | | |
| *132422* R HYDRAE — | | | | | | |
| | 3799.1 | 6.5 | Bl, | 3852.3 | 4.3 | Kd, |
| | 3815.1 | 6.0 | Bl, | 3853.2 | 4.3 | Ch, |
| | 3818.4 | 6.8 | Kd, | 3855.4 | 4.2 | Ch. |
| | 3820.4 | 6.6 | Kd, | 3856.2 | 4.4 | Kd, |
| | 3829.2 | 5.5 | Bl, | 3858.3 | 4.2 | Ch, |
| | 3830.4 | 6.0 | Ch, | 3858.3 | 4.2 | Kd. |
| | 3831.3 | 5.9 | Kd, | 3859.1 | 4.3 | Kd, |
| | 3836.2 | 5.6 | Kd, | 3860.3 | 4.2 | Kd, |
| | 3840.3 | 4.9 | Kd, | 3860.7 | 4.2 | L, |
| | 3842.0 | 4.8 | Bl, | 3873.1 | 4.4 | Kd, |
| | 3843.2 | 4.7 | Ch, | 3874.3 | 4.2 | Ch, |
| | 3845.2 | 4.5 | Ch, | 3878.7 | 4.1 | Pt, |
| | 3846.3 | 4.9 | Kd, | 3887.7 | 4.3 | Ca, |
| | 3846.8 | 4.2 | Pt, | 3891.7 | 4.5 | Ca. |
| | 3849.2 | 4.3 | Ch, | | | |
| *132706* S VIRGINIS— | | | | | | |
| | 3845.9 | 8.8 | Cy, | 3875.6 | 7.0 | Cy, |
| | 3846.7 | 8.8 | Ca, | 3877.7 | 7.5 | B, |
| | 3846.8 | 8.7 | Pt, | 3878.7 | 7.2 | Pt, |
| | 3848.8 | 8.7 | Sg, | 3879.6 | 7.1 | Ca, |
| | 3856.7 | 8.1 | Ca, | 3884.7 | 7.0 | Cy, |
| | 3858.8 | 7.8 | Cy, | 3884.7 | 6.8 | Hr, |
| | 3863.2 | 7.7 | Ch, | 3885.7 | 7.0 | Kl, |
| | 3865.7 | 7.7 | Ca, | 3886.8 | 6.5 | M. |
| | 3873.6 | 7.2 | Ca, | 3892.6 | 6.9 | Ca. |
| | 3874.8 | 6.8 | Sg, | | | |
| *133155* RV CENTAURI— | | | | | | |
| | 3799.2 | 9.4 | Bl, | 3826.0 | 9.6 | Bl, |
| | 3806.0 | 9.5 | Bl, | 3842.0 | 9.0 | Bl. |
| | 3815.1 | 9.4 | Bl, | | | |
| 133273 T URSAE MINORIS— | | | | | | |
| | 3883.6 | 9.2 | Wf, | 3884.7 | 9.6 | Br. |
| *133633* T CENTAURI— | | | | | | |
| | 3799.2 | 6.3 | Bl, | 3836.2 | 6.6 | Kd, |
| | 3814.4 | 7.0 | Kd, | 3842.0 | 6.5 | Bl, |
| | 3815.1 | 7.0 | Bl, | 3846.3 | 6.5 | Kd, |
| | 3821.3 | 7.1 | Kd, | 3856.2 | 6.1 | Kd, |
| | 3826.0 | 6.7 | Bl, | 3873.1 | 6.0 | Kd. |
| | 3829.3 | 6.7 | Kd, | | | |
| *134236* RT CENTAURI— | | | | | | |
| | 3799.2 | 12.2 | Bl, | 3826.0 | 12.1 | Bl, |
| | 3815.1 | 13.0 | Bl, | 3842.0 | 12.6 | Bl. |
| 134440 R CANUM VENATICORUM— | | | | | | |
| | 3839.6 | 7.8 | Ie, | 3878.7 | 8.6 | Pt, |
| | 3846.8 | 8.3 | Pt, | 3879.6 | 8.7 | Ie, |
| | 3854.6 | 8.2 | Ie, | 3880.6 | 8.9 | Ly, |
| | 3861.6 | 8.5 | M, | 3886.6 | 9.0 | Ly, |
| | 3869.6 | 8.7 | Ly, | 3886.8 | 8.9 | M, |
| | 3876.7 | 8.4 | Cy, | 3889.7 | 8.7 | Cy. |
| | 3877.6 | 8.6 | B, | | | |
| *134536* RX CENTAURI— | | | | | | |
| | 3799.2 | 12.4 | Bl, | 3842.0 | 13.5 | Bl. |
| | 3815.1 | 12.9 | Bl, | | | |
| *134677* T APODIS— | | | | | | |
| | 3815.1 | 12.9 | Bl, | 3842.0 | 10.6 | Bl. |
| | 3826.0 | 12.4 | Bl, | | | |
| *135908* RR VIRGINIS— | | | | | | |
| | 3851.8 | 13.3 | Pa, | 3877.8 | 14.4 | Pa, |
| | 3864.8 | 14.2 | Pa, | 3886.8 | 15.1 | Pa. |
| *140512* Z VIRGINIS— | | | | | | |
| | 3846.8 | 10.4 | Pt, | 3883.7 | 10.8 | B. |
| | 3878.7 | 10.8 | Pt, | | | |
| *140528* RU HYDRAE— | | | | | | |
| | 3799.2 | 12.9 | Bl, | 3829.2 | 10.6 | Bl, |
| | 3815.1 | 12.3 | Bl, | 3842.0 | 9.1 | Bl. |
| *140959* R CENTAURI— | | | | | | |
| | 3799.2 | 7.7 | Bl, | 3826.0 | 8.6 | Bl, |
| | 3806.0 | 7.9 | Bl, | 3842.0 | 9.6 | Bl. |
| | 3815.1 | 8.5 | Bl, | | | |
| 141567 U URSAE MINORIS— | | | | | | |
| | 3831.4 | 8.2 | Ch, | 3861.8 | 8.3 | M, |
| | 3845.2 | 8.1 | Ch, | 3871.2 | 8.3 | Ch, |
| | 3846.8 | 8.3 | Pt, | 3878.7 | 8.5 | Pt, |
| | 3851.2 | 8.1 | Ch, | 3889.7 | 8.6 | Kl. |
| 141954 S BOOTIS— | | | | | | |
| | 3843.7 | 9.0 | Sg, | 3875.7 | 10.9 | Sg, |
| | 3846.8 | 9.1 | Pt, | 3876.8 | 10.8 | Cy, |
| | 3856.8 | 9.9 | Sσ, | 3878.7 | 10.9 | Pt, |
| | 3860.3 | 10.0 | L, | 3880.7 | 11.0 | Hr. |
| 142539 V BOOTIS— | | | | | | |
| | 3839.7 | 10.0 | Hr, | 3869.6 | 9.1 | Ly, |
| | 3839.7 | 10.0 | Cy, | 3874.8 | 8.7 | Sg, |
| | 3839.8 | 10.5 | Sg, | 3875.6 | 8.2 | Cy, |
| | 3841.6 | 10.0 | Cy, | 3878.7 | 8.3 | Pt, |
| | 3846.8 | 8.8 | Pt, | 3878.7 | 8.0 | Al, |
| | 3851.8 | 9.0 | Sg, | 3879.6 | 7.9 | Ca. |
| | 3852.8 | 9.0 | Sg, | 3880.6 | 9.2 | Ly, |
| | 3856.7 | 9.0 | Ca, | 3884.7 | 7.9 | Cy, |
| | 3858.8 | 9.1 | Cy, | 3886.6 | 9.1 | Ly, |
| | 3860.4 | 8.1 | L, | 3886.8 | 8.3 | M, |
| | 3861.6 | 8.6 | M, | 3887.8 | 8.5 | Sg, |
| | 3864.9 | 8.6 | Cy, | 3891.5 | 7.9 | Ca. |
| | 3867.6 | 7.9 | Ca, | | | |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 142584 R CAMELOPARDALIS— | | | | | | |
| | 3846.8 | 12.0 | Pt. | | | |
| 143227 R BOOTIS— | | | | | | |
| | 3845.6 | 12.0 | Ie. | 3874.8 | 10.1 | Sg. |
| | 3846.8 | 12.1 | Pt, | 3878.7 | 10.5 | Pt, |
| | 3852.8 | 10.7 | Sg, | 3883.6 | 9.7 | B, |
| | 3856.7 | 11.6 | Ca, | 3884.8 | 10.1 | Sg, |
| | 3869.6 | 10.9 | Ie, | 3892.6 | 9.7 | Ca. |
| | 3873.6 | 11.1 | Ca, | | | |
| *143417* V LIBRAE— | | | | | | |
| | 3893.8 | 9.8 | Pa. | | | |
| 144918 U BOOTIS— | | | | | | |
| | 3861.8 | 11.3 | M, | 3883.7 | 9.9 | B. |
| *145254* Y LUPI— | | | | | | |
| | 3826.0 | 13.4 | Bl, | 3842.0 | 10.7 | Bl. |
| | 3831.2 | 12.8 | Bl, | | | |
| *145971* S APODIS— | | | | | | |
| | 3799.2 | 10.1 | Bl, | 3829.2 | 9.9 | Bl, |
| | 3806.0 | 10.0 | Bl, | 3842.0 | 10.2 | Bl. |
| | 3815.1 | 9.9 | Bl, | | | |
| *150018* RT LIBRAE— | | | | | | |
| | 3846.8 | 10.7 | Pt. | 3878.7 | 10.7 | Pt. |
| *150519* T LIBRAE— | | | | | | |
| | 3846.8 | 12.1 | Pt. | | | |
| *150605* Y LIBRAE— | | | | | | |
| | 3878.7 | 11.2 | Pt. | | | |
| *151520* S LIBRAE— | | | | | | |
| | 3831.4 | 10.8 | Ch, | 3878.7 | 10.2 | Pt. |
| | 3872.2 | 11.0 | Ch, | | | |
| 151714 S SERPENTIS— | | | | | | |
| | 3846.8 | 13.1 | Pt. | | | |
| 151731 S CORONAE BOREALIS— | | | | | | |
| | 3839.8 | 8.5 | Sg, | 3867.7 | 8.8 | Ca, |
| | 3843.7 | 8.4 | Ca, | 3873.8 | 9.0 | Sg, |
| | 3846.8 | 8.1 | Pt, | 3878.7 | 10.9 | Pt. |
| | 3852.8 | 8.6 | Sg, | 3885.7 | 9.3 | Kl, |
| | 3856.7 | 8.9 | Ca, | 3887.8 | 9.5 | Sg, |
| | 3861.7 | 8.9 | M, | 3892.6 | 9.6 | Ca. |
| *151822* RS LIBRAE— | | | | | | |
| | 3799.2 | 8.6 | Bl, | 3842.2 | 7.0 | Bl, |
| | 3815.1 | 8.4 | Bl, | 3860.7 | 7.9 | L. |
| | 3831.2 | 7.3 | Bl, | | | |
| *152714* RU LIBRAE— | | | | | | |
| | 3846.8 | 8.1 | Pt, | 3878.7 | 8.6 | Pt. |
| | 3860.7 | 8.7 | L, | 3880.8 | 8.7 | Cy. |
| | 3874.8 | 8.7 | Sg, | | | |
| *152849* R NORMAE— | | | | | | |
| | 3799.2 | 8.8 | Bl, | 3829.2 | 9.6 | Bl, |
| | 3815.1 | 9.0 | Bl, | 3842.0 | 9.4 | Bl. |
| *153020* X LIBRAE— | | | | | | |
| | 3799.2 | 11.7 | Bl, | 3842.2 | 11.5 | Bl. |
| | 3831.2 | 11.5 | Bl, | | | |
| *153215* W LIBRAE— | | | | | | |
| | 3831.2 | 13.8 | Bl. | | | |
| 153378 S URSAE MINORIS— | | | | | | |
| | 3838.6 | 8.7 | Ca, | 3867.6 | 8.3 | Ca, |
| | 3839.6 | 8.6 | Cy, | 3868.6 | 8.3 | Cy, |
| | 3839.7 | 8.4 | Hr, | 3875.6 | 8.5 | Cy, |
| | 3843.7 | 8.6 | Sg, | 3875.7 | 8.0 | Sg, |
| | 3846.8 | 8.6 | Pt, | 3878.7 | 8.2 | Pt, |
| | 3847.7 | 8.6 | Cy, | 3880.9 | 8.6 | Cy, |
| 153378 S URSAE MINORIS—Continued | | | | | | |
| | 3856.6 | 8.6 | Ca, | 3885.6 | 8.3 | Kl, |
| | 3856.8 | 8.8 | Sg, | 3889.6 | 8.5 | Cy. |
| | 3858.7 | 8.5 | Cy. | | | |
| *154020* Z LIBRAE— | | | | | | |
| | 3799.2 | 12.5 | Bl. | 3831.2 | 12.9 | Bl. |
| 154428 R CORONAE BOREALIS— | | | | | | |
| | 3814.4 | 6.0 | Kd, | 3869.7 | 6.0 | Wf. |
| | 3820.4 | 6.2 | Kd, | 3868.7 | 6.3 | Cy. |
| | 3829.3 | 6.2 | Kd, | 3869.7 | 6.2 | Ca, |
| | 3830.4 | 6.2 | Ch, | 3871.2 | 6.2 | Ch, |
| | 3832.7 | 6.2 | Cy, | 3871.6 | 6.2 | Kl, |
| | 3836.2 | 6.4 | Kd, | 3871.6 | 6.2 | Pt, |
| | 3838.9 | 6.2 | Wf, | 3872.7 | 6.3 | Cy, |
| | 3839.7 | 6.2 | Cy, | 3873.1 | 6.2 | Kd, |
| | 3839.7 | 6.3 | Hr, | 3873.6 | 6.0 | Al. |
| | 3839.8 | 6.0 | Sg, | 3873.7 | 6.1 | Ca, |
| | 3842.7 | 6.1 | Ca, | 3873.8 | 6.0 | Sg, |
| | 3843.7 | 6.2 | Ca, | 3874.2 | 6.2 | Ch, |
| | 3843.7 | 6.3 | Cy, | 3875.4 | 6.1 | L, |
| | 3844.7 | 6.2 | Wf, | 3875.6 | 6.3 | Cy, |
| | 3844.7 | 6.3 | Cy, | 3876.6 | 6.0 | Gb. |
| | 3844.8 | 6.2 | Sg, | 3876.8 | 6.3 | Cy. |
| | 3845.3 | 6.2 | Ch, | 3877.3 | 6.2 | Ch, |
| | 3845.9 | 6.3 | Cy, | 3877.7 | 6.2 | Kl, |
| | 3845.9 | 5.9 | Wf, | 3878.7 | 6.2 | Pt, |
| | 3846.3 | 5.7 | Kd, | 3878.7 | 6.0 | Kl, |
| | 3846.7 | 6.1 | Ca, | 3879.7 | 6.1 | Ca, |
| | 3846.8 | 6.0 | Wf, | 3879.8 | 6.1 | Pt, |
| | 3846.8 | 6.2 | Pt, | 3879.9 | 6.3 | Cy, |
| | 3846.9 | 7.0 | Al, | 3880.7 | 6.1 | Ca, |
| | 3847.7 | 6.3 | Cy, | 3880.7 | 6.3 | Cy, |
| | 3848.7 | 6.3 | Cy, | 3880.7 | 6.3 | Hr, |
| | 3848.7 | 6.0 | Wf, | 3881.6 | 6.1 | Ca. |
| | 3848.8 | 6.2 | Sg, | 3881.7 | 5.9 | Kl. |
| | 3849.7 | 5.9 | Gb, | 3881.8 | 6.0 | Sg. |
| | 3849.7 | 6.3 | Kl, | 3882.7 | 6.1 | Pt. |
| | 3851.2 | 6.1 | Ch, | 3883.7 | 6.0 | Kl, |
| | 3852.8 | 6.3 | Cy, | 3883.8 | 6.1 | Pt, |
| | 3852.8 | 6.2 | Sg, | 3884.7 | 6.3 | Hr, |
| | 3853.8 | 6.2 | Ie, | 3884.7 | 6.3 | Cy, |
| | 3854.2 | 6.1 | Ch. | 3885.8 | 5.4 | Kl. |
| | 3856.2 | 6.1 | Kd, | 3885.9 | 6.1 | Pt, |
| | 3856.7 | 6.0 | Ca, | 3886.6 | 6.2 | Ly. |
| | 3856.8 | 6.2 | Sg, | 3886.6 | 5.5 | Kl, |
| | 3857.7 | 6.1 | Ca, | 3886.6 | 6.2 | Ca, |
| | 3858.8 | 6.3 | Cy, | 3886.8 | 6.2 | M, |
| | 3859.9 | 6.3 | Cy, | 3886.9 | 6.2 | Pt, |
| | 3859.9 | 6.2 | Pt, | 3887.5 | 6.2 | Pt, |
| | 3860.6 | 6.0 | L, | 3887.6 | 6.2 | Ca, |
| | 3861.6 | 6.1 | L, | 3887.7 | 5.7 | Kl. |
| | 3861.7 | 6.2 | Pt, | 3887.8 | 6.2 | Sg, |
| | 3861.7 | 6.2 | M, | 3889.6 | 6.3 | Cy, |
| | 3863.2 | 6.2 | Ch, | 3889.7 | 5.8 | Kl, |
| | 3864.9 | 6.3 | Cy, | 3891.6 | 6.2 | Pt. |
| | 3865.7 | 6.1 | Ca, | 3891.7 | 6.2 | Ca, |
| | 3866.7 | 6.2 | Ca, | 3892.6 | 6.1 | Ca, |
| | 3867.3 | 6.0 | Kd, | 3893.6 | 6.0 | Kl. |
| | 3868.6 | 6.2 | Ca. | | | |
| 154536 X CORONAE BOREALIS— | | | | | | |
| | 3846.8 | 12.0 | Pt, | 3878.7 | 11.0 | Pt. |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 154615 R SERPENTIS— | | | | | | |
| | 3831.4 | 6.6 | Ch, | 3865.7 | 7.1 | Ca, |
| | 3842.8 | 6.6 | Ca, | 3873.8 | 7.4 | Sg, |
| | 3845.3 | 6.6 | Ch, | 3875.7 | 7.6 | Cy, |
| | 3846.7 | 6.7 | Ca, | 3878.7 | 7.6 | Pt, |
| | 3846.8 | 6.5 | Pt, | 3879.7 | 7.3 | Ca, |
| | 3849.8 | 7.2 | Sg, | 3884.7 | 7.8 | Cy, |
| | 3854.3 | 6.7 | Ch, | 3884.7 | 7.6 | Hr, |
| | 3856.7 | 6.9 | Ca, | 3886.6 | 7.8 | Ca, |
| | 3858.8 | 7.2 | Cy, | 3887.8 | 7.9 | Sg, |
| | 3861.8 | 7.0 | M, | 3889.7 | 7.3 | Kl. |
| | 3862.2 | 6.8 | Ch, | | | |
| 154639 V CORONAE BOREALIS— | | | | | | |
| | 3842.8 | 9.0 | Ca, | 3861.7 | 9.8 | M, |
| | 3846.8 | 8.5 | Pt, | 3878.7 | 8.9 | Pt, |
| | 3857.7 | 9.0 | Ca, | 3892.6 | 9.0 | Ca. |
| *155018* RR LIBRAE— | | | | | | |
| | 3831.4 | 9.0 | Ch, | 3872.3 | 10.8 | Ch. |
| | 3846.8 | 9.4 | Pt, | 3878.7 | 11.3 | Pt. |
| | 3860.7 | 10.5 | L, | | | |
| *155823* RZ SCORPII— | | | | | | |
| | 3846.8 | 11.8 | Pt. | | | |
| *160021* Z SCORPII— | | | | | | |
| | 3799.2 | 9.3 | Bl, | 3842.2 | 10.7 | Bl. |
| | 3831.2 | 10.7 | Bl, | | | |
| 160118 R HERCULIS— | | | | | | |
| | 3831.4 | 9.9 | Ch, | 3854.3 | 9.7 | Ch, |
| | 3845.3 | 9.5 | Ch, | 3868.2 | 10.6 | Ch, |
| | 3846.8 | 9.7 | Pt, | 3874.8 | 10.8 | Sσ, |
| | 3849.8 | 9.9 | Sg, | 3878.7 | 10.4 | Pt. |
| 160210 U SERPENTIS— | | | | | | |
| | 3845.9 | 11.8 | Cy, | 3890.8 | 10.8 | M. |
| | 3846.8 | 11.9 | Pt. | | | |
| 160625a RU HERCULIS— | | | | | | |
| | 3846.8 | 13.0 | Pt, | 3878.7 | 12.1 | Pt. |
| 160625b SX HERCULIS— | | | | | | |
| | 3846.8 | 8.0 | Pt, | 3882.7 | 8.8 | Pt, |
| | 3861.7 | 8.3 | Pt, | 3883.8 | 8.7 | Pt, |
| | 3861.7 | 8.4 | L, | 3885.9 | 8.7 | Pt, |
| | 3878.7 | 8.7 | Pt, | 3886.9 | 8.8 | Pt, |
| | 3879.8 | 8.6 | Pt, | 3887.5 | 8.6 | Pt. |
| *161122a* R SCORPII— | | | | | | |
| | 3831.2 | 13.0 | Bl, | 3874.8 | 10.2 | M, |
| | 3846.8 | 13.0 | Pt, | 3879.8 | 10.0 | Pt. |
| *161122b* S SCORPII— | | | | | | |
| | 3831.2 | 11.6 | Bl, | 3874.8 | 11.0 | M, |
| | 3842.2 | 10.5 | Bl, | 3879.8 | 11.7 | Pt. |
| | 3846.8 | 11.0 | Pt. | | | |
| 161138 W CORONAE BOREALIS— | | | | | | |
| | 3883.8 | 12.0 | Pt. | | | |
| *161607* W OPHIUCHI— | | | | | | |
| | 3846.8 | 11.6 | Pt, | 3883.8 | 12.7 | Pt. |
| *162112* V OPHIUCHI— | | | | | | |
| | 3846.8 | 8.4 | Pt, | 3883.8 | 7.4 | Pt, |
| | 3873.8 | 7.8 | Ca, | 3887.7 | 7.9 | Ca. |
| 162119 U HERCULIS— | | | | | | |
| | 3842.8 | 9.5 | Ca, | 3873.7 | 7.3 | Ca, |
| | 3846.8 | 8.6 | Pt, | 3874.8 | 7.8 | Sg, |
| | 3849.8 | 8.8 | Sg, | 3879.7 | 7.3 | Ca, |
| | 3853.8 | 7.8 | Ie, | 3883.8 | 7.0 | Pt, |
| | 3856.7 | 7.7 | Ca, | 3891.7 | 6.8 | Ca. |
| | 3865.7 | 7.6 | Ca, | | | |
| 162807 SS HERCULIS— | | | | | | |
| | 3846.8 | 10.1 | Pt, | 3883.8 | 9.8 | Pt. |
| | 3861.7 | 9.4 | L, | | | |
| *162815* T OPHIUCHI— | | | | | | |
| | 3831.2 | 12.3 | Bl, | 3883.8 | 9.8 | Pt. |
| | 3846.8 | 11.8 | Pt, | | | |
| *162816* S OPHIUCHI— | | | | | | |
| | 3831.2 | 9.5 | Bl, | 3842.2 | 9.6 | Bl. |
| 163137 W HERCULIS— | | | | | | |
| | 3846.8 | 13.1 | Pt, | 3885.8 | 13.5 | Pt. |
| 163266 R DRACONIS— | | | | | | |
| | 3831.4 | 10.4 | Ch, | 3867.7 | 7.6 | Ca, |
| | 3845.3 | 9.6 | Ch, | 3872.3 | 7.5 | Ch, |
| | 3846.5 | 9.6 | Ca, | 3879.6 | 7.3 | Ca, |
| | 3846.8 | 9.0 | Pt, | 3885.8 | 7.2 | Pt, |
| | 3851.2 | 8.2 | Ch, | 3891.7 | 7.1 | Ca. |
| | 3857.6 | 7.9 | Ca, | | | |
| *164319* RR OPHIUCHI— | | | | | | |
| | 3846.8 | 10.3 | Pt, | 3883.8 | 9.7 | Pt. |
| | 3860.7 | 9.9 | L, | | | |
| 164715 S HERCULIS— | | | | | | |
| | 3846.8 | 12.6 | Pt, | 3883.8 | 12.1 | Pt. |
| *164844* RS SCORPII— | | | | | | |
| | 3799.2 | 11.9 | Bl, | 3842.2 | 10.8 | Bl. |
| | 3831.2 | 11.2 | Bl, | | | |
| *165030* RR SCORPII— | | | | | | |
| | 3799.2 | 12.1 | Bl, | 3842.2 | 10.0 | Bl. |
| | 3831.2 | 11.0 | Bl, | | | |
| *165202* SS OPHIUCHI— | | | | | | |
| | 3846.8 | 11.6 | Pt, | 3883.8 | 12.8 | Pt. |
| 165631 RV HERCULIS— | | | | | | |
| | 3846.8 | 12.6 | Pt, | 3883.8 | 13.7 | Pt. |
| *170215* R OPHIUCHI— | | | | | | |
| | 3878.8 | 12.3 | Ie. | | | |
| 171401 Z OPHIUCHI— | | | | | | |
| | 3846.8 | 8.6 | Pt, | 3883.8 | 9.1 | Pt, |
| | 3873.8 | 9.1 | Ca, | 3887.8 | 9.7 | Ca. |
| 171723 RS HERCULIS— | | | | | | |
| | 3846.8 | 8.5 | Pt, | 3886.8 | 9.0 | M. |
| | 3883.8 | 8.8 | Pt, | | | |
| *172486* S OCTANTIS— | | | | | | |
| | 3831.2 | 13.4 | Bl. | | | |
| 172809 RU OPHIUCHI— | | | | | | |
| | 3846.8 | 9.0 | Pt, | 3883.8 | 11.2 | Pt. |
| *173543* RU SCORPII— | | | | | | |
| | 3799.2 | 10.9 | Bl, | 3842.2 | 12.7 | Bl. |
| | 3831.2 | 12.2 | Bl, | | | |
| *174406* RS OPHIUCHI— | | | | | | |
| | 3883.8 | 11.1 | Pt. | | | |
| 175111 RT OPHIUCHI— | | | | | | |
| | 3846.8 | 11.7 | Pt, | 3883.8 | 10.0 | Pt. |
| 175519 RY HERCULIS— | | | | | | |
| | 3846.8 | 12.5 | Pt, | 3883.8 | 13.0 | Pt. |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 175654 V DRACONIS— | | | | | | |
| | 3846.8 | 9.6 | Pt. | 3885.8 | 9.5 | Pt. |
| 180531 T HERCULIS— | | | | | | |
| | 3831.5 | 8.7 | Ch, | 3873.7 | 8.6 | Ca, |
| | 3842.8 | 8.0 | Ca, | 3876.8 | 8.4 | Ie, |
| | 3846.8 | 8.0 | Pt. | 3881.8 | 8.8 | Sg, |
| | 3853.8 | 8.2 | Ie, | 3885.8 | 8.5 | Pt, |
| | 3856.8 | 8.0 | Ca, | 3886.8 | 9.3 | M, |
| | 3859.4 | 8.0 | Ch, | 3887.7 | 9.5 | Ca. |
| | 3861.7 | 7.6 | L, | | | |
| 180565 W DRACONIS— | | | | | | |
| | 3846.8 | 12.4 | Pt. | | | |
| 180566 X DRACONIS— | | | | | | |
| | 3846.8 | 11.0 | Pt, | 3885.8 | 12.0 | Pt. |
| 180911 NOVA OPHIUCHI #4— | | | | | | |
| | 3846.8 | 13.4 | Pt, | 3885.8 | 13.6 | Pt. |
| 181103 RY OPHIUCHI— | | | | | | |
| | 3846.9 | 7.6 | Pt, | 3885.8 | 11.4 | Pt. |
| 181136 W LYRAE— | | | | | | |
| | 3842.8 | 7.9 | Ca, | 3865.8 | 8.5 | Ca, |
| | 3846.9 | 8.4 | Pt, | 3879.7 | 9.1 | Ca, |
| | 3856.8 | 8.2 | Ca, | 3881.8 | 9.1 | Sg, |
| | 3861.7 | 8.7 | L, | 3885.8 | 8.9 | Pt, |
| | 3861.7 | 9.3 | M, | 3891.7 | 9.3 | Ca. |
| *182133* RV SAGITTARII— | | | | | | |
| | 3831.2 | 9.1 | Bl, | 3842.2 | 8.3 | Bl. |
| 182306 T SERPENTIS— | | | | | | |
| | 3846.9 | 11.3 | Pt, | 3885.8 | 12.1 | Pt. |
| 183308 X OPHIUCHI— | | | | | | |
| | 3845.9 | 7.2 | Cy, | 3879.9 | 7.4 | Cy, |
| | 3846.9 | 6.6 | Pt, | 3885.8 | 7.5 | Pt, |
| | 3861.7 | 6.9 | L, | 3887.9 | 7.8 | Cy. |
| | 3864.9 | 7.4 | Cy, | | | |
| 184134 RY LYRAE— | | | | | | |
| | 3846.9 | 10.5 | Pt, | 3885.8 | 11.8 | Pt. |
| *184205* R SCUTI— | | | | | | |
| | 3812.4 | 5.4 | Kd, | 3864.9 | 6.3 | Cy, |
| | 3818.4 | 5.5 | Kd, | 3865.9 | 6.3 | Ca, |
| | 3820.4 | 5.4 | Kd, | 3867.3 | 6.3 | Kd, |
| | 3829.3 | 5.3 | Kd, | 3873.3 | 6.9 | Kd, |
| | 3831.3 | 5.3 | Kd, | 3873.8 | 7.0 | Ca. |
| | 3836.3 | 5.4 | Kd, | 3876.8 | 7.3 | Ie, |
| | 3840.3 | 5.5 | Kd, | 3879.8 | 7.8 | Ca, |
| | 3844.9 | 5.5 | Cy, | 3879.9 | 7.7 | Cy, |
| | 3845.9 | 5.8 | Cy, | 3879.9 | 7.7 | Ie, |
| | 3846.3 | 5.7 | Kd, | 3880.8 | 7.7 | Ie, |
| | 3846.5 | 5.6 | Ch, | 3883.8 | 7.4 | Pt. |
| | 3846.9 | 5.6 | Pt, | 3883.8 | 7.6 | Ie, |
| | 3852.9 | 5.9 | Cy, | 3884.8 | 7.7 | Ie, |
| | 3853.9 | 5.8 | Ie, | 3885.9 | 7.3 | Pt, |
| | 3856.3 | 5.8 | Kd, | 3886.9 | 7.3 | Pt, |
| | 3858.3 | 5.9 | Kd, | 3887.8 | 7.4 | Ca, |
| | 3859.4 | 6.2 | Ch, | 3887.8 | 7.4 | Ie, |
| | 3859.9 | 6.2 | Pt, | 3887.9 | 7.5 | Cy, |
| | 3859.9 | 5.8 | Cy, | 3888.8 | 7.3 | Ie, |
| | 3860.3 | 6.0 | Kd, | 3889.8 | 7.3 | Ie, |
| | 3860.7 | 6.2 | L, | 3891.8 | 7.2 | Ca. |
| 184243 RW LYRAE— | | | | | | |
| | 3883.8 | 12.0 | Pt, | 3891.8 | 11.2 | M. |
| 184300 NOVA AQUILAE #3— | | | | | | |
| | 3846.9 | 10.7 | Pt, | 3876.8 | 10.5 | Ie, |
| | 3853.9 | 10.4 | Ie, | 3883.8 | 10.6 | Pt, |
| | 3859.4 | 10.4 | Ch, | 3885.9 | 10.7 | Pt, |
| | 3859.9 | 10.6 | Pt, | 3888.9 | 10.4 | Ie. |
| | 3873.8 | 10.4 | Ca, | | | |
| *185437a* S CORONAE AUSTRALIS— | | | | | | |
| | 3831.3 | 12.2 | Bl. | | | |
| *185437b* CPD 17°8450— | | | | | | |
| | 3831.3 | 10.6 | Bl, | 3842.3 | 10.7 | Bl. |
| | *3842.2* | 10.6 | Bl, | | | |
| *185537a* R CORONAE AUSTRALIS— | | | | | | |
| | 3831.3 | 12.8 | Bl. | | | |
| *185537b* T CORONAE AUSTRALIS— | | | | | | |
| | 3831.3 | 13.3 | Bl. | | | |
| *185512a* ST SAGITTARII— | | | | | | |
| | 3851.5 | 8.5 | Ch. | | | |
| 185634 Z LYRAE— | | | | | | |
| | 3883.8 | 10.6 | Pt. | | | |
| 190108 R AQUILAE— | | | | | | |
| | 3846.9 | 7.0 | Pt, | 3883.8 | 6.4 | Pt, |
| | 3859.5 | 6.1 | Ch, | 3887.8 | 7.3 | Ca, |
| | 3873.8 | 6.4 | Ca, | 3891.8 | 6.2 | M. |
| 190529a V LYRAE— | | | | | | |
| | 3883.8 | 13.5 | Pt. | | | |
| *190819a* RW SAGITTARII— | | | | | | |
| | 3859.5 | 10.0 | Ch. | | | |
| *190907* TY AQUILAE— | | | | | | |
| | 3883.8 | 10.5 | Pt. | | | |
| 190926 X LYRAE— | | | | | | |
| | 3846.9 | 9.0 | Pt. | 3883.8 | 8.9 | Pt. |
| 190967a U DRACONIS— | | | | | | |
| | 3846.9 | 14.0 | Pt, | 3883.8 | 13.9 | Pt. |
| *191007* W AQUILAE— | | | | | | |
| | 3883.8 | 8.5 | Pt. | | | |
| *191019* R SAGITTARII— | | | | | | |
| | 3883.8 | 12.2 | Pt. | | | |
| *191033* RY SAGITTARII— | | | | | | |
| | 3831.3 | 9.4 | Bl, | 3859.5 | 9.1 | Ch, |
| | 3842.2 | 9.3 | Bl, | 3885.9 | 9.6 | Pt, |
| | 3848.5 | 9.4 | Ch, | 3886.9 | 9.4 | Pt. |
| | 3851.5 | 9.2 | Ch, | | | |
| *191124* TY SAGITTARII— | | | | | | |
| | 3831.3 | 11.6 | Bl, | 3842.2 | 11.6 | Bl. |
| *191319* S SAGITTARII— | | | | | | |
| | 3831.3 | 10.2 | Bl, | 3883.8 | 12.0 | Pt. |
| | 3842.2 | 10.1 | Bl, | | | |
| 191350 TZ CYGNI— | | | | | | |
| | 3846.9 | 10.7 | Pt, | 3883.8 | 9.5 | Pt. |
| 191637 U LYRAE— | | | | | | |
| | 3846.9 | 9.0 | Pt, | 3883.8 | 8.7 | Pt. |
| 193311 RT AQUILAE— | | | | | | |
| | 3846.9 | 13.8 | Pt, | 3883.8 | 11.0 | Pt. |
| 193449 R CYGNI— | | | | | | |
| | 3859.9 | 13.6 | Pt. | 3885.9 | 13.5 | Pt. |
| 193509 RV AQUILAE— | | | | | | |
| | 3859.9 | 10.8 | Pt, | 3885.9 | 12.5 | Pt. |
| *193972* T PAVONIS— | | | | | | |
| | 3798.0 | 8.1 | Bl, | 3822.0 | 8.6 | Bl, |
| | 3806.0 | 7.5 | Bl, | 3831.3 | 8.5 | Bl, |
| | 3814.9 | 8.0 | Bl, | 3842.3 | 9.4 | Pl. |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est. | Obs. | J.D. | Est. | Obs. |
|---|---|---|---|---|---|---|
| 194048 RT CYGNI— | | | | | | |
| | 3831.5 | 7.6 | Ch. | 3865.7 | 7.6 | Ca. |
| | 3842.8 | 7.8 | Ca. | 3875.7 | 7.7 | Cy. |
| | 3845.9 | 7.8 | Cy. | 3879.7 | 7.7 | Ca. |
| | 3855.4 | 7.2 | Ch. | 3879.8 | 8.1 | Cy. |
| | 3856.7 | 7.8 | Ca. | 3882.9 | 8.2 | Sg. |
| | 3859.9 | 7.4 | Cy. | 3885.9 | 7.9 | Pt. |
| | 3859.9 | 7.3 | Pt. | 3886.8 | 8.0 | M. |
| | 3860.8 | 7.4 | M. | 3891.7 | 8.0 | Ca. |
| | 3864.9 | 7.6 | Cy. | | | |
| 194348 TU CYGNI— | | | | | | |
| | 3859.9 | 11.8 | Pt. | 3890.8 | 8.4 | M. |
| | 3885.9 | 10.1 | Pt. | | | |
| 194604 X AQUILAE— | | | | | | |
| | 3859.9 | 10.9 | Pt. | 3885.9 | 12.3 | Pt. |
| 194632 $\chi$ CYGNI— | | | | | | |
| | 3814.4 | 7.9 | Kd. | 3858.5 | 9.5 | Ch. |
| | 3828.5 | 8.3 | Ch. | 3859.9 | 9.0 | Pt. |
| | 3829.3 | 8.7 | Kd. | 3865.8 | 9.8 | Ca. |
| | 3842.9 | 8.6 | Ca. | 3885.9 | 10.8 | Pt. |
| | 3846.5 | 8.9 | Ch. | 3887.8 | 10.8 | Ca. |
| | 3851.5 | 9.4 | Ch. | | | |
| 195553 NOVA CYGNI #3— | | | | | | |
| | 3846.9 | 11.2 | Pt. | 3878.7 | 11.5 | Pt. |
| | 3859.9 | 11.2 | Pt. | 3879.8 | 11.5 | Pt. |
| | 3873.7 | 11.8 | Ca. | 3883.8 | 11.1 | Pt. |
| 195849 Z CYGNI— | | | | | | |
| | 3859.9 | 12.0 | Pt. | 3885.9 | 12.4 | Pt. |
| 200212 SY AQUILAE— | | | | | | |
| | 3859.9 | 8.8 | Pt. | 3885.9 | 10.5 | Pt. |
| 200357 S CYGNI— | | | | | | |
| | 3859.9 | 13.6 | Pt. | | | |
| 200514 R CAPRICORNI— | | | | | | |
| | 3885.9 | 10.0 | Pt. | | | |
| 200715a S AQUILAE— | | | | | | |
| | 3859.9 | 9.8 | Pt. | 3890.8 | 9.6 | M. |
| | 3885.9 | 9.9 | Pt. | | | |
| 200715b RW AQUILAE— | | | | | | |
| | 3859.9 | 9.2 | Pt. | 3890.8 | 8.8 | M. |
| | 3885.9 | 9.2 | Pt. | | | |
| 200747 R TELESCOPII— | | | | | | |
| | 3798.0 | 11.2 | Bl. | 3842.3 | 12.6 | Bl. |
| 200822 W CAPRICORNI— | | | | | | |
| | 3885.9 | 11.4 | Pt. | | | |
| 200906 Z AQUILAE— | | | | | | |
| | 3885.9 | 13.4 | Pt. | | | |
| 200916 S SAGITTAE— | | | | | | |
| | 3890.8 | 8.9 | M. | | | |
| 200938 RS CYGNI— | | | | | | |
| | 3831.5 | 7.5 | Ch. | 3859.9 | 7.8 | Cy. |
| | 3845.9 | 7.3 | Cy. | 3864.9 | 7.7 | Cy. |
| | 3846.5 | 7.4 | Ch. | 3875.7 | 7.5 | Cy. |
| | 3851.5 | 7.2 | Ch. | 3882.9 | 7.3 | Sg. |
| | 3859.4 | 7.3 | Ch. | 3885.9 | 7.2 | Pt. |
| | 3859.9 | 7.3 | Pt. | 3887.9 | 7.5 | Cy. |
| 201008 R DELPHINI— | | | | | | |
| | 3853.9 | 9.6 | Ie. | 3878.8 | 11.2 | Ie. |
| | 3859.9 | 9.6 | Pt. | 3885.9 | 11.2 | Pt. |
| 201121 RT CAPRICORNI— | | | | | | |
| | 3885.9 | 6.7 | Pt. | | | |
| 201130 SX CYGNI— | | | | | | |
| | 3885.9 | 13.2 | Pt. | | | |
| 201139 RT SAGITTARII— | | | | | | |
| | 3842.3 | 11.4 | Bl. | | | |
| 201437b WX CYGNI— | | | | | | |
| | 3859.9 | 12.4 | Pt. | 3885.9 | 12.2 | Pt. |
| 201647 U CYGNI— | | | | | | |
| | 3859.9 | 9.2 | Pt. | 3885.9 | 9.2 | Pt. |
| | 3873.8 | 9.9 | Ca. | 3887.8 | 9.9 | Ca. |
| 202210 U MICROSCOPII— | | | | | | |
| | 3798.0 | 7.0 | Bl. | 3842.3 | 9.2 | Bl. |
| 202539 RW CYGNI— | | | | | | |
| | 3891.8 | 9.0 | M. | | | |
| 202817 Z DELPHINI— | | | | | | |
| | 3859.9 | 13.1 | Pt. | | | |
| 202946 SZ CYGNI— | | | | | | |
| | 3841.6 | 9.8 | Pt. | 3882.7 | 9.7 | Pt. |
| | 3846.9 | 8.8 | Pt. | 3883.8 | 9.6 | Pt. |
| | 3859.9 | 8.8 | Pt. | 3885.8 | 9.8 | Pt. |
| | 3878.7 | 9.2 | Pt. | 3891.8 | 9.2 | M. |
| | 3879.8 | 9.3 | Pt. | | | |
| 202954 ST CYGNI— | | | | | | |
| | 3824.2 | 10.2 | Wf. | 3885.9 | 12.1 | Pt. |
| | 3859.9 | 11.5 | Pt. | | | |
| 203226 V VULPECULAE— | | | | | | |
| | 3859.9 | 8.6 | Pt. | 3885.9 | 8.7 | Pt. |
| 203816 S DELPHINI— | | | | | | |
| | 3859.9 | 9.6 | Pt. | 3885.9 | 9.1 | Pt. |
| 203847 V CYGNI— | | | | | | |
| | 3846.5 | 9.0 | Ch. | 3859.9 | 7.9 | Pt. |
| | 3855.5 | 9.5 | Ch. | 3885.9 | 8.4 | Pt. |
| 204102 V AQUARII— | | | | | | |
| | 3885.9 | 8.6 | Pt. | | | |
| 204846 RZ CYGNI— | | | | | | |
| | 3835.6 | 12.6 | Wf. | 3885.9 | 13.4 | Pt. |
| | 3859.9 | 13.3 | Pt. | | | |
| 204954 S INDI— | | | | | | |
| | 3798.0 | 10.0 | Bl. | 3821.9 | 9.0 | Bl. |
| | 3806.0 | 9.4 | Bl. | 3842.3 | 9.7 | Bl. |
| | 3815.0 | 9.2 | Bl. | | | |
| 205923 R VULPECULAE— | | | | | | |
| | 3859.9 | 8.2 | Pt. | 3885.9 | 8.7 | Pt. |
| 210129 TW CYGNI— | | | | | | |
| | 3853.9 | 12.2 | Ie. | | | |
| 210382 X CEPHEI— | | | | | | |
| | 3852.8 | 15.5 | Pa. | 3893.8 | [14.0 | Pa. |
| | 3877.8 | 14.8 | Pa. | | | |
| 210812 R EQUULEI— | | | | | | |
| | 3885.9 | 11.9 | Pt. | | | |
| 210868 T CEPHEI— | | | | | | |
| | 3843.5 | 8.5 | Pt. | 3867.7 | 7.5 | Ca. |
| | 3846.5 | 8.8 | Ch. | 3879.6 | 7.3 | Ca. |
| | 3846.7 | 8.1 | Ca. | 3882.9 | 7.0 | Sg. |
| | 3851.5 | 8.4 | Ch. | 3885.7 | 7.7 | Kl. |
| | 3856.7 | 8.1 | Ca. | 3886.9 | 7.0 | Sg. |
| | 3861.3 | 8.0 | L. | 3891.7 | 6.9 | Ca. |
| 212030 S MICROSCOPII— | | | | | | |
| | 3798.0 | 9.4 | Bl. | | | |

VARIABLE STAR OBSERVATIONS, February 20 to April 20, 1924—Continued.

| Star | J.D. | Est.Obs. | J.D. | Est.Obs. |
|---|---|---|---|---|
| 213244 W CYGNI— | | | | |
| | 3813.9 | 5.9 Kd, | 3856.3 | 6.1 Kd, |
| | 3817.9 | 6.0 Kd, | 3860.3 | 6.2 Kd, |
| | 3820.9 | 6.1 Kd, | 3867.3 | 6.2 Kd, |
| | 3831.4 | 6.0 Kd, | 3878.3 | 6.0 Kd. |
| | 3840.3 | 6.0 Kd, | | |
| 213678 S CEPHEI— | | | | |
| | 3843.5 | 7.5 Pt, | 3886.9 | 8.4 Pt. |
| 213753 RU CYGNI— | | | | |
| | 3859.9 | 8.2 Pt, | 3890.8 | 8.6 M. |
| | 3886.9 | 8.3 Pt, | | |
| 213843 SS CYGNI— | | | | |
| | 3822.0 | [11.3 Ch, | 3869.7 | 11.7 Ie, |
| | 3834.5 | 11.8 Ie, | 3873.8 | 11.5 Ca, |
| | 3835.5 | 11.4 Wf, | 3874.8 | 11.8 M, |
| | 3838.5 | 11.6 Ie, | 3875.8 | 11.5 Ie, |
| | 3838.5 | 11.6 Cd, | 3876.8 | 11.6 Ie, |
| | 3839.5 | 11.6 Ie, | 3877.5 | [10.9 Ch, |
| | 3841.6 | 11.7 Pt, | 3878.8 | 11.8 Ie. |
| | 3842.5 | 11.7 Cd, | 3879.7 | 11.6 Ca, |
| | 3842.5 | 11.7 Ie, | 3879.8 | 11.8 Pt, |
| | 3842.9 | 11.5 Ca, | 3879.9 | 11.5 Ie, |
| | 3843.5 | 11.7 Pt, | 3879.9 | [10.9 Cy, |
| | 3845.5 | 11.7 Ie, | 3880.8 | 11.5 Ie, |
| | 3845.9 | 12.0 Cy, | 3880.9 | [11.3 Cy, |
| | 3846.5 | 11.0 Ch, | 3883.8 | 11.6 Ie, |
| | 3846.9 | 10.6 Pt, | 3883.8 | 11.2 Wf, |
| | 3847.5 | 10.2 Ch, | 3883.8 | 11.6 Pt, |
| | 3847.5 | 10.2 Ie, | 3884.8 | 11.5 Ie, |
| | 3848.5 | 8.9 Ch, | 3885.7 | [11.3 Kl, |
| | 3851.5 | 8.3 Ch, | 3885.9 | 11.8 Pt, |
| | 3852.9 | 8.6 Ie, | 3886.9 | 11.7 Pt, |
| | 3853.9 | 8.6 Ie, | 3887.8 | 11.5 Ca, |
| | 3854.5 | 9.2 Cd, | 3887.8 | 11.0 Ie, |
| | 3855.4 | 8.4 Ch, | 3887.9 | 11.1 Cy, |
| | 3858.5 | 9.8 Ch, | 3888.9 | 10.2 Ie, |
| | 3858.9 | 10.2 Ie, | 3889.8 | 10.0 Kl, |
| | 3859 5 | 10.7 Ch, | 3889.8 | 10.0 Ie, |
| | 3859.9 | 10.5 Pt, | 3890.8 | 10.2 M, |
| | 3859.9 | 11.1 Cy, | 3891.8 | 9.7 Ca, |
| | 3861.6 | 11.6 L, | 3891.8 | 9.6 M. |
| | 3861.9 | 11.5 Ie. | 3892.7 | 9.1 Ca, |
| | 3864.9 | 11.5 Cy, | 3892.8 | 8.7 Ie. |
| 213937 RV CYGNI— | | | | |
| | 3859.9 | 6.5 Pt, | 3886.9 | 6.7 Pt. |
| 214024 RR PEGASI— | | | | |
| | 3886.9 | 9.1 Pt, | | |
| *214247* R GRUIS— | | | | |
| | 3798.0 | 11.7 Bl, | 3815.0 | 12.1 Bl. |
| | 3806.0 | 11.8 Bl, | | |
| 215605 Y PEGASI— | | | | |
| | 3886.9 | 11.5 Pt. | | |
| 215934 RT PEGASI— | | | | |
| | 3886.9 | 11.2 Pt. | | |
| *220133a* RY PEGASI— | | | | |
| | 3841.5 | 9.3 Pt, | 3886.9 | 9.4 Pt. |
| *222439* S LACERTAE— | | | | |
| | 3841.5 | 10.5 Pt. | 3886.9 | 7.9 Pt. |
| *222867* R INDI— | | | | |
| | 3815.0 | 11.8 Bl. | 3840.9 | 8.9 Bl. |
| | 3822.0 | 10.4 Bl, | | |
| 223841 R LACERTAE— | | | | |
| | 3841.5 | 9.6 Pt. | 3886.9 | 11.9 Pt. |
| 230759 V CASSIOPEIAE— | | | | |
| | 3839.5 | 10.4 Cy, | 3842.7 | 10.4 Sg. |
| | 3841.5 | 10.1 Pt. | 3886.9 | 11.7 Pt. |
| | 3846.5 | 10.2 Ca, | | |
| 231425 W PEGASI— | | | | |
| | 3829.1 | 9.4 Ch. | | |
| 232848 Z ANDROMEDAE— | | | | |
| | 3829.1 | 9.8 Ch. | 3841.5 | 9.9 Pt. |
| 233335 ST ANDROMEDAE— | | | | |
| | 3829.1 | 9.5 Ch. | 3841.5 | 8.7 Pt, |
| | 3837.7 | 9.2 Sg. | 3886.9 | 10.0 Pt. |
| *233815* R AQUARII— | | | | |
| | 3820.9 | 7.2 Kd. | 3823.9 | 7.0 Kd. |
| 235350 R CASSIOPEIAE— | | | | |
| | 3837.5 | 6.5 Ly, | 3857.6 | 6.3 Ly, |
| | 3838.5 | 6.4 Cy, | 3860.5 | 6.1 Ly, |
| | 3838.6 | 6.4 Ca, | 3865.5 | 6.5 Ca. |
| | 3841.6 | 6.3 Lv, | 3867.5 | 6.5 Ly, |
| | 3843.5 | 6.3 $Ly_a$ | 3873.5 | 6.7 Ly, |
| | 3843.5 | 6.4 Ca, | 3873.9 | 6.6 Ca. |
| | 3845.5 | 6.8 Cy, | 3884.5 | 6.7 Ly, |
| | 3848.6 | 6.6 Ly, | 3891.8 | 7.0 Ca. |
| | 3857.5 | 6.6 Ca. | | |
| 235525 Z PEGASI— | | | | |
| | 3841.5 | 9.0 Pt. | | |
| 235939 SV ANDROMEDAE— | | | | |
| | 3841.5 | 13.0 Pt, | 3886.9 | 9.0 Pt. |

SUMMARIES

| | Feb. 20-Mar. 20 | Mar. 20-Apr. 20 | Totals |
|---|---|---|---|
| Observations | 1283 | 1382 | 2665 |
| Stars Observed | .... | .... | 323 |
| Observers | 25 | 21 | 29 |

The following observers contributed to this report: Messrs. Allen "Al", Baldwin "Bl", Bouton "B", Brocchi "Br", Carr "Ca", Chandler "Cd", Chandra "Ch", Chisolm "Cm", Cilley "Cy", Fisher "Fi", Gaebler "Gb", Henry "Hr", Miss Holmes "Hm", Iedema "Ie", Jones "Js", Kanda "Kd", Kleis "Kl", Lacchini "L", Leavenworth "Lv", Lefever "Lf", Mrs. Lytle "Ly" McAteer "M", Marshall "Mh", Parkhurst "Pa", Peltier "Pf", Skaggs "Sg", Waterfield "Wf", Yalden "Ya", and Miss Young "Y".

HOWARD O. EATON, Recording Secretary.

## COMET AND ASTEROID NOTES.

**Comet 1924 *a* (Reid).** — The Copenhagen Circular No. 40 gives a corrected ephemeris of this comet, a part of which extends through the month of June. The comet will be too nearly in line with the sun to be seen by northern observers.

EPHEMERIS OF COMET 1924 *a* (REID).

| Greenwich M. T. 1924 | α h m s | δ ° ′ | Log *r* | Log Δ |
|---|---|---|---|---|
| June 1 | 5 42 21 | −7 15 | | |
| 5 | 5 49 59 | −6 11 | 0.3348 | 0.4709 |
| 9 | 5 57 23 | −5 11 | | |
| 13 | 6 04 35 | −4 15 | 0.3470 | 0.4855 |
| 17 | 6 11 35 | −3 22 | | |
| 21 | 6 18 23 | −2 33 | 0.3593 | 0.4982 |
| 25 | 6 25 00 | −1 47 | | |
| 29 | 6 31 27 | −1 05 | 0.3715 | 0.5108 |

**Ephemeris of (4) Vesta.** — In *Astronomische Nachrichten* No. 5287, Mr. N. Samoilow, of Petrograd, gives the following ephemeris of the asteroid (4) Vesta. As the magnitude of the planet will be 6.4 at the time of opposition, it may be that some of our readers may care to follow its motion across the sky.

OPPOSITION EPHEMERIS FOR (4) VESTA.

| Greenwich M. T. 1924 | α h m s | δ ° ′ | Log Δ |
|---|---|---|---|
| June 10.5 | 22 23 28 | −13 59.3 | 0.2322 |
| 20.5 | 22 30 10 | −14 07.3 | 0.2059 |
| 30.5 | 22 34 17 | −14 33.7 | 0.1802 |
| July 10.5 | 22 35 32 | −15 19.4 | 0.1561 |
| 20.5 | 22 33 47 | −16 23.2 | 0.1353 |
| 30.5 | 22 29 05 | −17 41.5 | 0.1196 |
| Aug. 9.5 | 22 21 52 | −19 06.3 | 0.1106 |
| 19.5 | 22 13 05 | −20 28.6 | 0.1098 |
| 29.5 | 22 03 54 | −21 38.7 | 0.1173 |
| Sept. 8.5 | 21 55 49 | −22 29.1 | 0.1327 |
| 18.5 | 21 49 30 | −22 56.7 | 0.1544 |
| 28.5 | 21 46 04 | −23 01.7 | 0.1806 |
| Oct. 8.5 | 21 45 39 | −22 46.3 | 0.2096 |
| 18.5 | 21 48 09 | −22 13.6 | 0.2398 |
| 28.5 | 21 53 17 | −21 26.3 | 0.2701 |
| Nov. 7.5 | 22 00 42 | −20 26.8 | 0.2997 |

## COMMUNICATIONS.

**Occultation of Aldebaran.** — In pursuance of the suggestion made by Father Rigge in a recent issue of POPULAR ASTRONOMY we observed here at Woodstock the daylight occultation of Aldebaran on April 8. The time of immersion was recorded on the Observatory chronograph, but unfortunately the record of the moment of emersion was lost due to an inadvertent opening of the circuit from the equatorial room to the chronograph after immersion. The approximate time however of emersion was noted as $3^h\ 25^m$ E. S. T.; this is probably correct to within about one minute: the time of immersion is probably

correct to within about half a second. The observed and computed times are as follows:

| | Computed | Observed |
|---|---|---|
| | d h m | h m s |
| Immersion | April 8 6 53.6 | 6 53 25 G. M. T. |
| Emersion | 8 25.2 | 8 25 .. |

Immersion occurred 10$^s$ before the predicted time as computed from the data and formulae given in the American Ephemeris.

EDWARD C. PHILLIPS, P. J.

Woodstock College Observatory, Woodstock, Md.

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**Occultation of $\gamma$ Virginis.**—On the evening of April 17 while examining the moon with a small glass I noticed a bright star near which would soon be occulted. I immediately brought out my larger telescope and set it on the star. I found the star to be double so I watched with interest. As soon as the first component vanished I counted seconds until the other went. From my hurried observation it appeared that a line joining the two components was almost parallel to the line of the moon's motion.

I looked up the star in the *American Ephemeris* and found it was $\gamma$ Virginis. I then looked up the moon's motion in R. A. and Dec. for this time and found the resultant of these two motions. This came out 36.4 seconds of an arc for one minute of time. As ten seconds elapsed between the two occultations I divided the above result by 6 which gave 6".06 as the distance between the stars. I looked up the measured distance of the stars and found it to be (1900) 5".8 with the pair slowly widening. The occultation took place at 7$^h$ 50$^m$ P. S. T.

LELAND S. BARNES.

310 So. Vendome St., Los Angeles, Calif.

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**A Bright Meteor.**—On May 1, while returning home from giving our high school Junior play at Ness City, Kansas, I saw a very bright meteor at 11:45 P. M. As we were riding along, the landscape was suddenly lighted up as bright as at noonday, accompanied by a faint rumbling. The auto top prevented me from seeing the meteor when it was brightest. The bright light lasted about five seconds. By the time the meteor was low enough to see through the windows, it was nearly out and had a very slow motion, and no tail to speak of. The meteor disappeared as a dark red light about twenty degrees above the southeastern horizon. This meteor was the brightest I have ever seen in my young astronomical career.

CLYDE W. TOMBAUGH.

Burdett, Kans.

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**Signaling Mars in August.**—How a radio signal does reach a station across the earth is one of the vast number of unsolved mysteries of radio. How it would be possible to reach from one planet to another is a stretch of imagination which has only been made possible by the tremendous achievements of the last few years.

Astronomers, radio experts, scientists, and fans of various denominations, are keenly interested in the effort to reach Mars either by radio or light waves. The attempt will be made from the summit of the Jungfrau, 14,000 feet up in the Alps, next August, when the planet will be only 34,600,000 miles away. Mars will be nearest the earth on August 22, yet this may not prove to be the most

favorable opportunity for successful transmissions or reception. The problem is fraught with so many limitations that superficially it seems next to impossible. This old world, however, will receive a thrill it has never experienced heretofore should communication be established with our next door neighbor.

The stupendous interest manifested in this international experiment has also evolved innumerable theories. Bold and thrilling as the whole affair may seem, the writer is one who believes the attempt within the range of possibilities. He therefore would offer a suggestion that these experiments might be continued from the first part of August through the first week of September. According to a theory of his own, possibly the evenings of August 6 and September 6 or thereabout, are the most feasible times for transmission or reception.

Should any success reward these confident and bold investigators it will be of great importance to note the exact time and location, as these data no doubt will materially assist in solving many of the mystifying problems radio has to deal with at the present time.

EDWARD A. OSSE.

Philadelphia, May 5, 1924.

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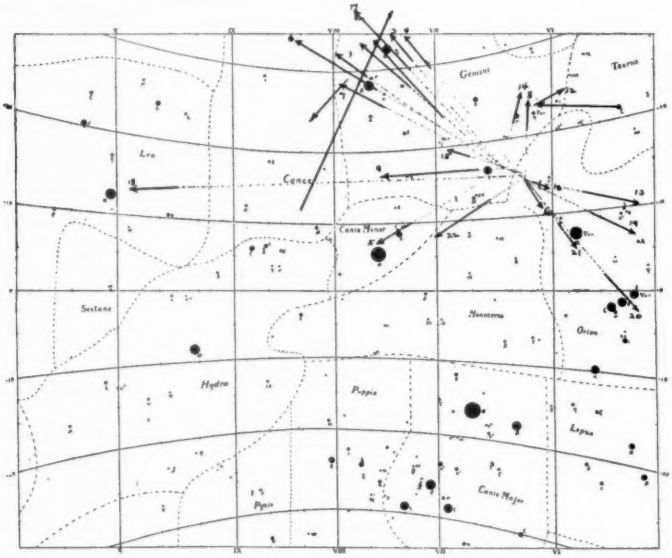
**The Orionids, 1923.**— The weather was not very favorable for a series of observations of the Orionids, but the sky was clear on the 19th, 21st and 24th. It was quite clear that last year's fine display was not repeated. In fact the shower was rather feeble and of short duration. The hourly rate was one-fifth as great as in 1922. On the 24th not one was seen, although there were active radiants elsewhere.




Orionids, October 21, 1923.

The radiant was close to Nu Orionis on the 19th, while on the 21st it had shifted unmistakably northeast. This is the third time that this observer has

noticed beyond a doubt that it is a shifting radiant. The individual members were plotted without prejudice and an open mind, and fresh maps were used as always for each evening. The tabulated results are as follows:

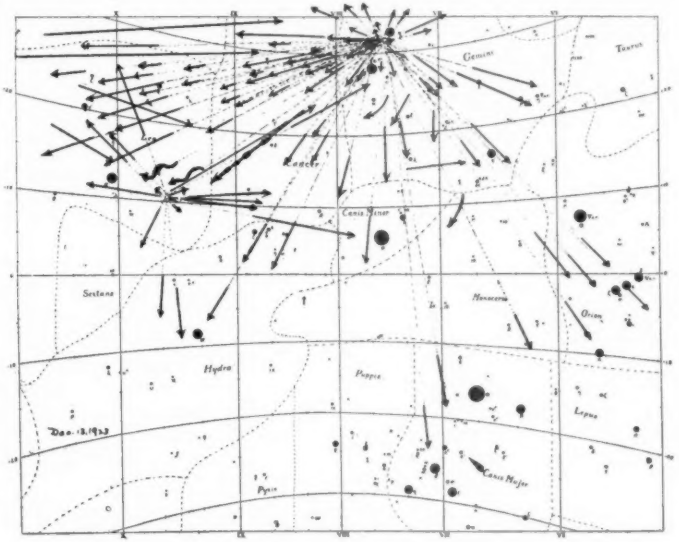
| Date | Magnitudes 0 | 1 | 2 | 3 | 4 | 5 | 6 | Totals | |
|---|---|---|---|---|---|---|---|---|---|
| Oct. 19, '23 | 1 | 2 | 3 | 5 | 0 | 3 | 1 | 15 | 10 white, 4 red, 1 blue, 3 were streaked. |
| Oct. 21, '23 | 0 | 2 | 5 | 3 | 4 | 5 | 3 | 22 | 12 white, 10 red, 1 streaked. |

| | Radiant | | | |
|---|---|---|---|---|
| Oct. 19, '23 | 15.0 | 91° 14′ | +15° | Hourly rate 15. Paths, short, swift. |
| Oct. 21, '23 | 14.5 | 92° 15′ / 94° 12′ | +15° / +17° | Hourly rate 23. Paths, short, swift. |

R. M. Dole.

East Lansing, Michigan.

**The Geminids, 1923.**— Splendid weather for this series was experienced for the first time in many years. However, the 12th was overcast and rainy and it was not possible to discover whether the maximum of this shower occurred on the 12th or 13th. Possibly the English observers had good weather the night of the 12th. Very few were observed prior to the 12th, except some bright

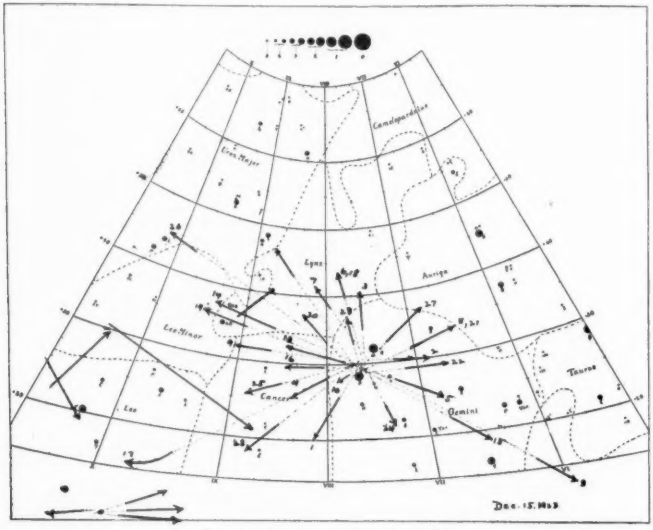



Geminids, December 13, 1923.

individuals at widely scattered intervals. The scarcity was noticed on the 11th, only 6 being mapped in about an hour's watch. Last year also there were very few up to the 12th. It suddenly cleared off cold and dazzlingly bright about 13.5 a. m. of the 13th, when observations began. It was seen at once that the Geminids were unusually active. In fact they were so numerous that it was impossible to map all of them. The hourly rate from (13.5) 1:30 a. m. to (14.5) 2:30 a. m. was 86 an hour for one observer, but it is likely that there were over a hundred per hour. The hourly rate diminished slowly until (15.5) 3:30 a. m.

when observations ceased. A watch was kept on the 14th, but very few were seen. It clouded over at (14.0) 2:00 a. m. On the 15th, when there was another brilliantly clear night 28 were counted in one hour, all rather faint. There was another less active shower near o Leonis; they were slow and left trains. Several very fine Quadrantids swept with great swiftness through Leo into Gemini, leaving trains.

It is possible that the maximum of the Geminids occurred on the 13th earlier in the day or even on the 12th, as they fell off in rate after 2:00 a. m. (14:00) of the 13th. There were times when there were several in a minute. The Geminids as a rule are very short and elusive and rarely leave trains. Two




Geminids, December 15, 1923.

were observed to burst and two were like snakes, a peculiarity that the observer has seen in former years. The majority of the Geminids emanated northward; the ones that moved eastward were noticeably yellow in color and in some cases brilliant. It takes an alert eye to correctly trace back the point of emanation. The radiant was again observed to shift east by east-northeast. The tabulated results are as follows:

December 6 to 12, 26 were observed; December 13, 110; December 15, 28.
Dec. 13, 1923, 16 o Leonids, 3 Quadrantids.
Dec. 15, 1923, 3 o Leonids, 3 Quadrantids.

| | | Magnitudes. Geminids. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | —3 | —2 | —1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Totals |
| Dec. | 13 | 2 | 2 | 5 | 15 | 15 | 14 | 22 | 13 | 10 | 12 | 110 |
| " | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 3 | 9 | 11 | 28 |

| | | | Time | Radiant | | | | |
|---|---|---|---|---|---|---|---|---|
| Dec. | 9 | 1923 | 14.0 | 108.4° | +33° | | | |
| " | 11 | " | 14.0 | 110.5° | +32° | Leo, Dec. 13, 1923 | | |
| " | 13 | " | 13.5 | 112.6° | +31° | 13.5 | 146.0° | +11° |
| " | 15 | " | 13.0 | 114.0° | +30° | | | |

East Lansing, Michigan. R. M. Dole.

**The Andromedids, 1923.** — Some bright fire-balls were reported during the first five days of November, emanating from Andromeda. Two were also observed on November 1 and 2, 1923. The first one was estimated as —3 magnitude, of a deep yellow color, leaving a train along its length of varying thickness and intensity. It was very slow in motion and swept clear to the western horizon. The one on the 2nd of November was a splendid object equal to a moon at the quarter, of a distinct yellow color leaving a livid green trail equal in places along its path to Sirius. It lit up the landscape and was an object of beauty. It burst four times along its visible path. It swept in very slow majestic splendor to the southwest horizon. The two fire-balls took 3 and 6 seconds respectively to cross the sky. On mapping these objects it became certain that they were Bielids or Andromedids. On the 21st watch was made for a return of these fragments of Biela's comet. Three bright ones were seen early in the evening. There was not a general activity noticed, and it is to be wondered if they will return in 1924 about the 21st or much earlier.

R. M. Dole.

East Lansing, Michigan.

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**Illusory Variation of Starlight.** — The following occurrence, though trivial, I consider worth mentioning.

Near the end of my night's work with the large reflector, on the morning of May first, I looked from one of the dome windows to see how bright the dawn was becoming. In the northeast I noticed a star which appeared of unusual brightness for that part of the sky. The dawn was very strong. At first I suspected the star to be a nova, but a pair of field glasses enabled me to pick up a star above it (Gamma Persei) which identified it as Alpha Persei. I could not see Delta, as it was lower down in the brighter dawn. The identification of Alpha was checked by following the line Alpha, Beta, Gamma Andromedae, which points to Alpha Persei.

The apparently unusual brightness, the low altitude, and the bright sky illumination suggested that the same combination of circumstances may have caused the report of the outburst of Beta Ceti last year. That nothing unusual has happened to Alpha Persei I am quite certain. I believe the discoverer of the "outburst" may have been deceived as I was deceived, and that in this simple observation may lie the explanation of the "outburst."

Dean B. McLaughlin.

Ann Arbor, May 26, 1924.

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## GENERAL NOTES

**Ernest Fox Nichols,** director of research, Nela Research Laboratories, Cleveland, died in Washington on the morning of April 29, while reading a paper before the National Academy of Sciences.—(*Science*, May 2, 1924.)

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**Dr. C. V. L. Charlier,** professor of astronomy and director of the observatory of the University of Lund, gives the Hitchcock lectures at the University of California this year. The general subject is "The structure of the universe," and the titles of the lectures are: "Historical introduction," "Star gauges of William Herschel," "The milky way," "Steady stellar systems," "An

infinite world." He will also offer a course in the intersession on "The motion of the stars," and one in the summer session on "The distribution of the stars.—(*Science*, April 25, 1924.)

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**The John Fritz Gold Medal** was presented to Dr. Ambrose Swasey, of Cleveland, at a public ceremony in the Engineering Societies Building, New York, on April 23, for achievement as a designer and manufacturer of instruments and machines of precision, a builder of great telescopes, a benefactor of education and the founder of Engineering Foundation. Addresses were made by Charles F. Rand, Dr. William Wallace Campbell, General William Crozier and Dr. John R. Freeman. Representatives of engineering societies and other organizations from all parts of the country were present.—(*Science*, April 25, 1924.)

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**The Transit of the Mercury** on May 7 was well seen here with the exception of slight cloudiness at internal contact. During the entire day a haze overspread the sky, becoming at times quite thick, but this thinned out and cleared away about two minutes before first contact was scheduled to occur. Mr. Seagrave observed with the 4-inch mounted on a portable stand while I observed with the 8½-inch refractor, casting the image of the sun on a piece of white paper. The time keeper used was a very fine watch set by U. S. Naval Observatory time and checked by radio time signals for several days previous.

| | |
|---|---|
| External (first) contact | $4^h\ 42^m\ 35^s$ E. S. T. |
| Internal (second) contact | $4^h\ 45^m\ 3^s$ E. S. T. (?) |

As stated above, the time of second contact is in doubt as a haze had begun to come in which precluded the possibility of accurate observation. No halo nor any surfaee markings were seen.

LEWIS J. BOSS.

Pine Hill Laboratory, North Scituate, R. I., May 8, 1924.

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**The Transit of Mercury.** —Plans for observing the transit of Mercury at the Yerkes Observatory on the afternoon of May 7 were foiled completely by a thoroughly cloudy sky which persisted through the day. We had intended to observe the entrance of the planet upon the sun's disk with the spectroheliograph, operated by Mr. Lee, and also to secure occasional spectroheliograms of the planet on the disk at points selected from a spectroheliogram where the greatest contrasts would occur between the light and dark background. We further planned to secure photographs of the transit at regular intervals with the 12-inch telescope, to be carried out by Messrs. Barrett and Van Biesbroeck. These photographs were to be taken with the new plateholders and exposing shutter which have lately been finished in our shop. The shutter carries a yellow Jena filter. An electrical contact is arranged so that the chronograph records automatically the instant when the exposure is made. We are now using the new shutter for our routine daily photographs of the sun, and expect that, with the use of plates bathed for slowness, we shall be able to employ a very much larger portion of the aperture of the 12-inch telescope, perhaps as much as 8 inches.

EDWIN B. FROST.

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**The Transit of Mercury of May 7, 1924.**—Observations of the beginning of the transit of Mercury were made by projecting with the 20-inch refractor an image of the sun about three feet in diameter upon a glazed white card,

attached by a frame to the telescope. The position of the limb at which ingress was to occur was carefully centered on the card and the attention concentrated upon that point. The times were recorded by chronograph.

Three times were recorded by myself:

| | G. M. T. h m s | |
|---|---|---|
| 1. When planet was first recognized | 9 42 11 | Probably 2ˢ or 3ˢ late. |
| 2. When planet was judged to be tangent to the sun's limb, internally | 9 44 41 | Uncertain by at least 3ˢ. |
| 3. When the "Black drop" let go | 9 44 59 | Uncertain by 1ˢ or 2ˢ. |

Times were also recorded by Assistant Professor B. W. Sitterly and students N. W. Storer and U. S. Lyons, all three using a chronometer and noting the times by the "eye and ear" method. The following are their results:

| | G. M. T. h m s | |
|---|---|---|
| B. W. S. First Contact | 9 42 4 | Perhaps 2ˢ late. |
| Internal tangency | 9 44 25 | |
| N. W. S. First contact | 9 42 5 | Perhaps 2ˢ late. |
| First glimpse of light betweeen planet and sun's limb | 9 44 44 | |
| U. S. L. First contact | 9 42 59 | Decided notch in sun before recognized. |
| Internal tangency | 9 44 46 | |
| "Completely on" | 9 45 4 | |

During the above observations the sun's limb was clear, but very unsteady. Clouds were rapidly rising from the west.

After the contacts were noted, the solar photographic apparatus was attached to the 20-inch and several photographs taken through the clouds. The east and west line was determined by pin points at the edge of the plate carrier. The apparatus is adjusted so that a sun-spot will trail across both points. The images of the points are printed on the plate at the edges of the sun. The times of exposure were recorded by chronograph. Two of the plates were measured with the Gaertner measuring machine, with the following results:

| Plate | G. M. T. h m s | E-W diam. mm | N-S diam. mm | Coördinates of Mercury. mm | mm |
|---|---|---|---|---|---|
| C | 10 18 44.6 | 77.26 | 77.66 | From E 10.97 | From N 21.00 |
| D | 10 21 59.0 | 77.50 | 77.67 | 11.57 | 21.33 |

No corrections have been applied for refraction or other distortions. Barometer, 29.4 inches. Attached thermometer, 72°. Outside thermometer, 62°.

The diameter of the image of Mercury on both plates is .39 mm. On account of the fuzziness of the image and the raggedness of the sun's limb the above figures may be in error by .01 or .02 mm. The error in orientation will probably introduce even greater errors in the co-ordinates of the planet.

FREDERICK SLOCUM.

Van Vleck Observatory, Middletown, Conn.
May 24, 1924.

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**The Cleveland Astronomical Society** has just closed its second successful year. The organization has had the privilege of hearing the following distinguished speakers: Dr. Shapley of Harvard, Director Hussey of University of Michigan, Dr. D. C. Miller of Case School of Applied Science, and Professors Michelson and Moulton of the University of Chicago.

The annual election of the Society was held on May 2 at the Warner and Swasey Observatory, Cleveland, Ohio. Prof. Nassan demonstrated a very ingenious model of the sun, earth and moon. The large telescope was used on a number of objects.

The following officers and executive committee were chosen:

President—O. L. Dustheimer.
Vice-President—Albert Schroeder.
Secretary-Treasurer—Raymond A. Gordon.

*Executive Committee.*

| | |
|---|---|
| Prof. J. J. Nassan | David Dietz |
| J. W. Patterson | Opal Reams |

Action was taken on a resolution which will permit a greater variety of topics for meetings. These will be held under three groups:

General Meetings in charge of President Dustheimer.
Advanced Group Meetings in charge of Professor Nassan.
Amateur Group Meetings in charge of Albert Schroeder.

Every member will receive notice of all meetings and may attend all if he so desires.

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**Yerkes Observatory Lantern Slides.**—Lantern slides are a necessity today in teaching astronomy. In order to meet this need a number of the observatories of the country,including the Yerkes, Mt. Wilson, Lick, and Goodsell observatories, for some years have been offering lantern slide copies of their choicest negatives practically at cost. The Yerkes Observatory has recently offered a selected list of 100 slides of the sun, moon, planets, comets, stars and clusters, nebulae, Milky Way, stellar spectra, buildings and instruments. For these slides there may also be obtained descriptions of each slide printed on 4 x 6 cards. The slides and cards together form a valuable contribution either for class room use or for popular lectures. The entire set of slides and cards can be obtained from The University of Chicago Press, Chicago, Ill., for $65.00. Single slides and cards may be had for 75 cents and 5 cents respectively.

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**The Depths of the Universe,** by George Ellery Hale. This is a small book of three chapters, which have appeared recently in Scribner's Magazine. The chapters have the titles: "The Depths of the Universe;" "Barnard's Dark Nebulae;" and "Sunspots as Magnets." They relate chiefly to observations and discoveries made at the Mount Wilson Observatory, and bring down to date the statement of our knowledge concerning the subjects mentioned in the titles of the chapters.

The book is splendidly printed on plate paper and is illustrated with most excellent reproductions of recent photographs.

The publishers are Charles Scribner's Sons, New York and London.

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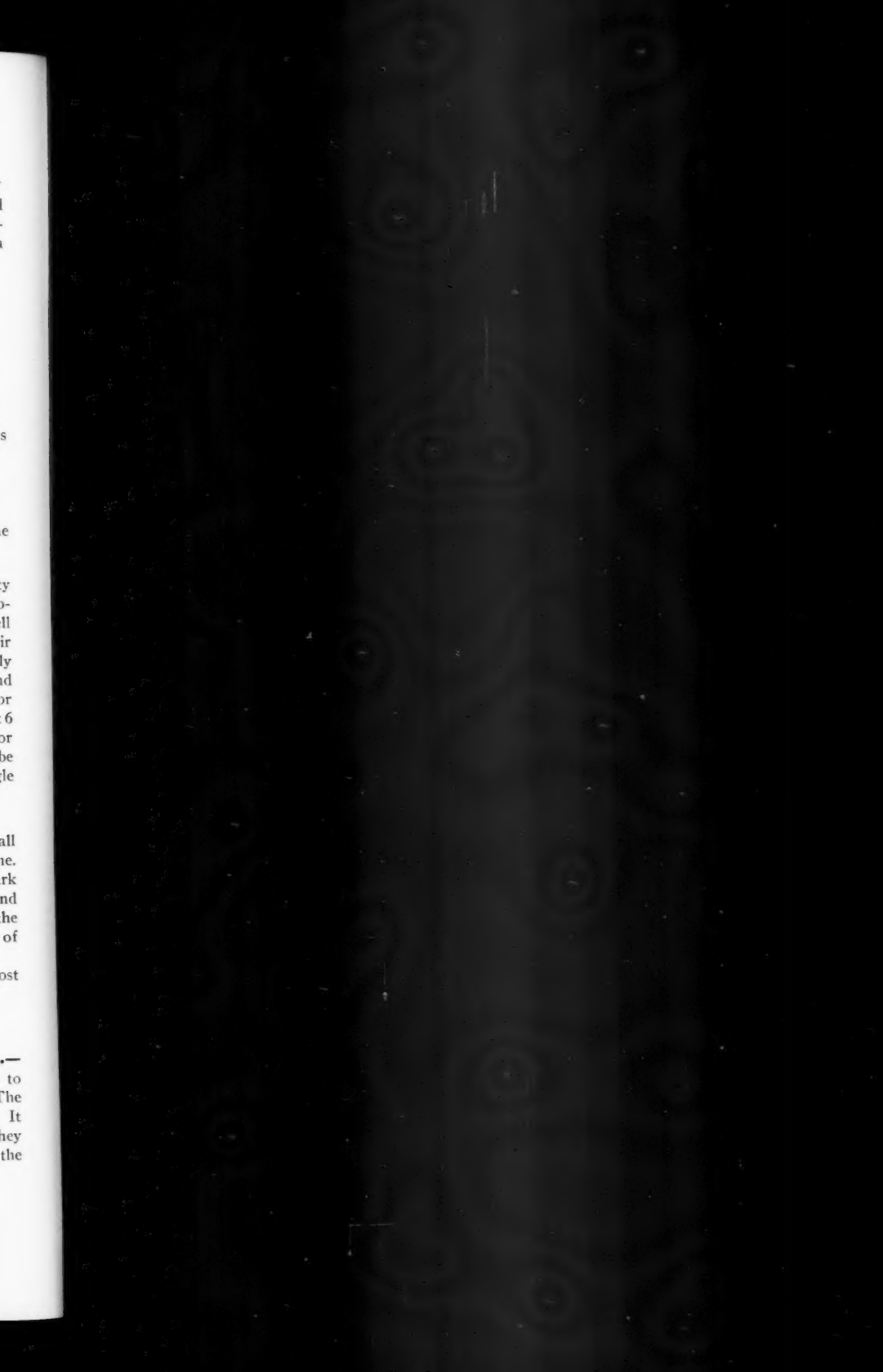
**Relations Between the Masses and Luminosities of the Stars.**—A very remarkable paper on this subject was presented by A. S. Eddington to the meeting of the Royal Astronomical Society, London, on March 14, 1924. The paper is printed in full in the *Monthly Notices* of the R.A.S. for March. It appears to show that all stars,—dwarfs as well as giants,—radiate as if they obey the laws of a perfect gas and that luminosity is primarily a function of the mass.